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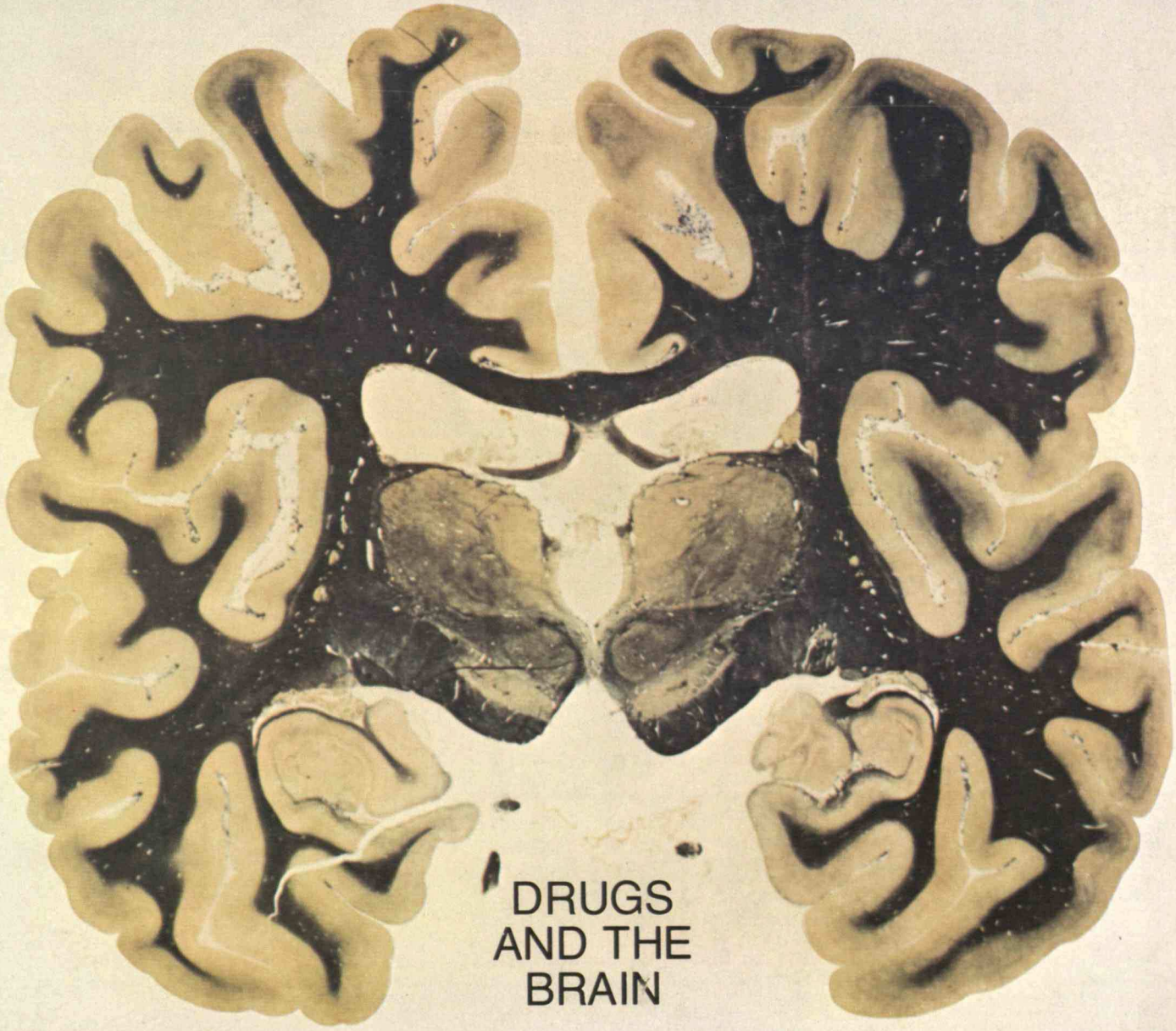

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* * *

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Articles

Departments

The First Line

"Without geometry, math would be just a poor figure of speech."

We were pleased to hear again from Eve R. Wirth, formerly a teacher in the New York public school system. Ms. Wirth reported her students' reactions to engineering in the *Review* for May, 1975 (*p. 4*). Now she's collected their malapropisms on mathematics, and we share them with you herewith:

"Rhombus is a Spanish dance you do in the 1950s."

"Question: What is a pentagon? Answer: An eight-sided general."

"Take a good long fat look at a nice triangle. Does it have three sides that close? No to this question? Then you are for sure not looking a fat look at a nice triangle."

"Parallelograms can fool you because sometimes they tilt."

"A circle has 360 degrees for all practical purposes."

"The importance of geometry to math is that without geometry, math would be just a poor figure of speech.

"When you have a postulate, then you know for sure that you are not round-shouldered."

"What a trapezoid is has a very short memory on my part."

"When you see a four-sided triangle, you know right away it has to be a square or a rectangle. How its corners are situated tells the true story."

"Math has been around for figuring since the beginning of time, and maybe even before this."

"As it stands now, we have discovered many answers to many unknown math problems. Now we have to find out what problems these answers fit to."

Letters

A Rejoinder from Puthoff and Targ

In Martin Gardner's article on "Magic and Paraphysics" (*June, pp. 42-51*) some references were made to the work with Uri Geller at Stanford Research Institute. Unfortunately, Gardner's statements concerning what happened at S.R.I. and what we published are grossly in error. We therefore wish to inform your readers of the facts involved, all of which can be independently verified on the basis of information available in the public domain.

To begin, Gardner states that "Although Puthoff and Targ are personally convinced of Geller's ability to bend metal by PK (psychokinesis) and to perform even more remarkable miracles, their *Nature* report was limited to Geller's power of E.S.P. (extrasensory perception)."

Gardner is wrong on both counts. We are in fact *not* convinced of Geller's ability to bend metal, and our negative findings *were* reported in the very *Nature* article to which Gardner refers (R. Targ and H. Puthoff, vol. 252, No. 5476, p. 604): "It has been widely reported that Geller has demonstrated the ability to bend metal by paranormal means. Although metal bending by Geller has been observed in our laboratory, we have not been able to combine such observations with adequately controlled experiments to obtain data sufficient to support the paranormal hypothesis." A more detailed statement is found in the S.R.I. film, *Experiments with Uri Geller,* the text of which was released accompanying a March 6, 1973, presentation at a Columbia University physics colloquium. With regard to metal bending, the text states: "One of Geller's main attributes that had been reported to us was that he was able to bend metal. . . . In the laboratory we did not find him able to do so. . . . [it] becomes clear in watching this film that simple photo interpretation is insufficient to determine whether the metal is bent by normal or paranormal means. . . . It is not clear whether the spoon is being bent because he has extraordinarily strong fingers and good control of micro-manipulatory movements, or whether in fact the spoon 'turns to plastic' in his hands, as he claims."

In discussing our dice-box experiment, Gardner goes on to claim that the reported run of correct guesses as to which die face was uppermost was selected out of a longer run which included "many prior trial runs." That is completely false. The facts are exactly as reported in the *Nature* paper and in the S.R.I. film. The experiment was performed ten times, with Uri passing twice and giving a correct response eight times. These ten trials were the *only* ten; they were not selected out of a longer run — there were *no* prior trials nor follow-up trials, as Gardner claims.

Gardner's errors appear to be due to his taking at face value the erroneous speculations of Geller's self-appointed debunker, the Amazing Randi.

H. E. Puthoff
R. Targ
Menlo Park, Calif.

Messrs. Puthoff and Targ are with the Electronics and Bioengineering Laboratory of Stanford Research Institute. — Ed.

Martin Gardner replies:

I have enormous admiration for the expertness of Puthoff and Targ in one field — verbal obfuscation. Let me take each of their two counts in turn:

Count 1. When I say that Puthoff and Targ are "personally convinced" of Geller's ability to bend metal, I use the phrase in the ordinary language sense, as when an astronomer says he is personally convinced that quasars are not within our galaxy. It is a probability estimate, as are all scientific beliefs. When Puthoff and Targ deny they are convinced Geller can bend metal, they mean they are not "convinced" because they have not proved such ability in their laboratory. Privately, in letters and conversation, they have expressed their personal beliefs that Geller has such ability. If Puthoff and Targ wish to make precise their present beliefs about Geller's PK powers, let them give it as a probability estimate: How do they *now* rate the probability that Geller has PK ability? If they rate it low, it means they have changed their minds.

In my article I said that Jack Sarfatti, the paraphysicist who first staked his reputation on the PK powers of Uri Geller, but who recently branded Geller a fraud, "did not doubt" that others have PK ability. Sarfatti telephoned me to say that this is not true. He *does* doubt the existence of PK. He then added that he doubts "everything" except the existence of himself. This surprised me because I doubt even my own existence — for all I know I may be just a figment in the Red King's dream (consult Lewis Carroll's *Through The Looking Glass*). When I said Sarfatti does not doubt PK, I meant it only in the ordinary language sense, as when a physicist says he does not doubt electromagnetism.

Count 2. I did *not* say in my article that in the dice-box test Puthoff and Targ selected ten guesses out of a longer run. I said that many "prior trial runs" had been made. A trial run, in ordinary language, is a practice run. Yet every time someone points out that practice runs were made with the dice-box, Puthoff and Targ obfuscate by denying that the ten guesses were "selected" from previous trials. They were not so selected.

But that is not the point. The point is that a very large number of practice runs were made during which Geller was allowed to handle the box. This gave him all the time he needed to devise a method of cheating when the final test of ten trials was made. That was all I said and all I meant.

Anyone reading the letter from Puthoff and Targ would assume that there were no practice runs. Without drawing upon private information, I content myself with the following published data:

— In the July, 1973, issue of *Psychic* there are two photographs of Geller performing the dice-box test. In the first picture we see Geller recording his guess of the die's face, the closed box about four inches from his hand, while Targ watches. In the second, we see Geller opening the box to check on his guess. We assume it is the box used in the famous test because we see S.R.I. printed on top. In the obfuscatory Puthoffian-Targian dialect, this is not a "follow-up trial" because it is not part of the test they reported.

— In John Wilhelm's carefully researched book, *The Search for Superman,* just published by Pocket Books, there is a report on dice-box tests conducted in Geller's motel room. Geller did all the shaking, al-

Martin Gardner's article on "Magic and Paraphysics" which stimulates some of the correspondence on this page was one of five contributions to the June *Review* honoring Philip Morrison, Institute Professor of Physics at M.I.T., on his 60th birthday. Here, Professor Morrison holds the photograph that appeared on the magazine's cover — the gift of Charles Eames. The issue was a surprise to Professor Morrison; it culminated many months' effort on the part of Phylis Morrison and Professor Kenneth Brecher, co-editors, and of the writers whose friendship was symbolized by their contributions: Hans Bethe, Frank Drake, Martin Gardner, Jerome Lettvin, Frank Oppenheimer, and Cyril Smith.

though Puthoff insists it was vigorous enough to "ensure an honest shake." Commented Targ: "He's like a kid in that he had something that made a lot of noise and he just shook and shook it." Targ also told Wilhelm that in the famous run of ten Geller was allowed to place his hands on the box in a dowsing fashion.

Targ told Wilhelm that S.R.I. has a good-quality videotape of another dice test in which Geller, five times in a row, correctly wrote down the die's number *before* the box was shaken. Targ first shook the box, then Geller took it and dumped out the die. Since magicians familiar with dice cheating know a variety of ways to control a fair die when it is dumped out of a box, how about letting magicians see this valuable videotape? Why keep it top secret? Targ was so impressed by *this* test that he told Wilhelm he suspects that, even in the run of ten that they reported, Geller probably used precognition, not clairvoyance, to guess the number he later "would see when he opened the box." Note: Targ said it was Geller who opened the box!

In the sound track of the S.R.I. film from which Puthoff and Targ quote in their letter, the following occurs: "Here is another double-blind experiment in which a die is placed in a metal file box. . . . The box is shaken up with neither the experimenter nor Geller knowing where the die is or which face is up. This is a live experiment that you see — in this case, Geller guessed that a four was showing but first he passed because he was not confident. You will note he was correct and he was quite pleased to have guessed correctly, but this particular test does not enter into our statistics."

Now Puthoff and Targ have not, so far as I know, revealed whether this single trial, which was recorded on videotape, was part of *the* test of ten trials. If it was not, then surely it was in a practice run. If it was, then presumably the entire dice-box test was recorded on videotape. In the interest of scientific truth, Puthoff and Targ should make this entire videotape available to inspection by magicians. It then could be determined unequivocally whether the theory suggested by James Randi, as to how Geller might have cheated, is a viable one. Come, gentlemen, let us see the entire tape! If we are wrong, we will humbly apologize.

The Amazing Randi replies:
Martin Gardner hardly needs to use my speculations as a basis for his conclusions on the matter of Puthoff and Targ. Any intelligent person looking into the situation can easily come to the conclusion that I have. And my "speculations" are being daily established as facts — as witness John Wilhelm's book on the S.R.I. experiments. How Puthoff and Targ can persist in the face of such evidence of sloppy research is a matter for some considerable wonder among laymen. . . .

"We Did Not Almost Lose Detroit"

Peter Gwynne, in his review of John Fuller's book *We Almost Lost Detroit (February, pp. 25-28),* states that Mr. Fuller has presented a "factual account" of the Fermi fuel melting incident. I disagree since Mr. Fuller, in my view, mixes fiction with fact, along with colorful language and gross distortions, to weave his story. Mr. Gwynne was right in his first thought that the book "was yet another semi-hysterical tilt at the putative evils of the nuclear reactor."

Mr. Gwynne says, "It was not until months later that experts dared to probe the core." The fact is that two days after the incident, each and all safety rods were withdrawn and then re-inserted into the core to obtain pertinent data. Successive probes for information were made as procedures and tools therefore were developed and approved to be certain that

Continued on p. 5

Outrageous Fortune

Technology/Society
by
Kenneth E. Boulding

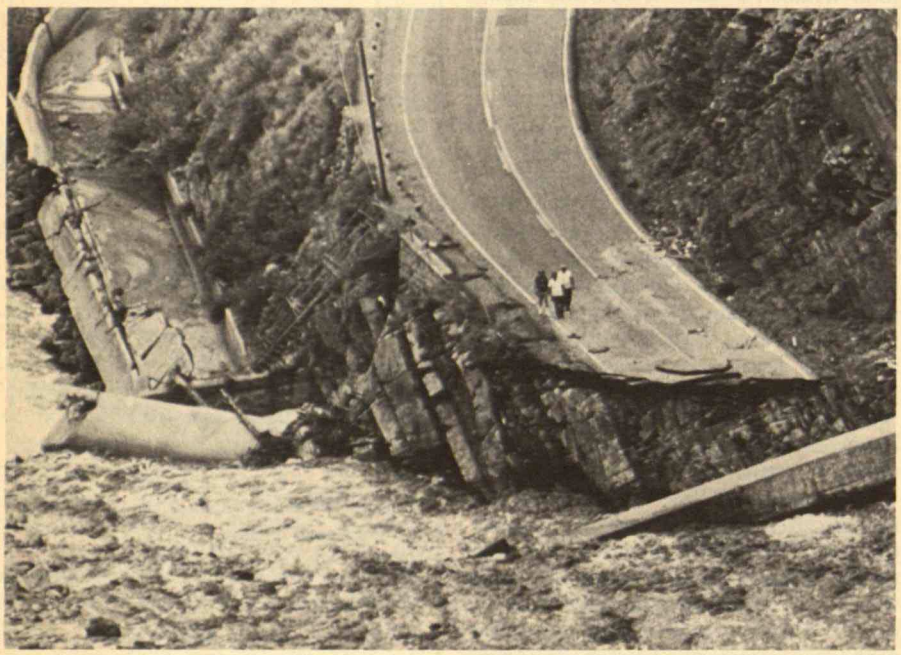
Nonlinearity and uncertainty are conditions of the real world. They were brought home to me with unusual force as the result of the catastrophic flood in Big Thompson Canyon, 30 miles from where I live and work.

Catastrophe could almost be defined as an event rare enough to be usually somewhere else: an earthquake in China, a flood in India, a civil war in Lebanon. Once in a lifetime, however, the improbable happens and catastrophe strikes close to home. Catastrophes happen when the ordinary quantities of the world go beyond their normal range either in excess or deficiency. If we draw a "goodness function," $G=F_g(x)$, with goodness appearing on the vertical axis and some variable x, that determines goodness, on the horizontal axis, it is likely to be nonlinear and discontinuous — a sort of parabola with cliffs. The amount of water in a stream is an excellent example of a goodness function — one of the innumerable variables that can be measured on the horizontal axis. If there is not enough water, the stream runs dry and that is bad. As the amount of water rises, so does the goodness of the stream. But at a certain point the stream begins to flood and its goodness diminishes. At a further point, its goodness falls catastrophically, almost to negative infinity — as it did at the Big Thompson, with the loss of over a hundred lives and millions of dollars in property.

I am the fortunate owner of a cabin by a waterfall on a little stream, some 20 miles south of the Big Thompson. The storm that was so catastrophic in the canyon created a little flood on my stream that was wholly delightful. My family plunged in the waterfall, splashed in the pools, and paddled in the stream, which at this time of year is usually pretty dry. The flood did no damage and no doubt helped to fill the irrigation reservoirs downstream.

The same weather conditions that created a nightmare 20 miles away were thus at my cabin an unqualified good. Yet if the storm had struck 30 or 40 miles to the south, as it might well have done, it would have caused a catastrophe in Boulder far greater than the one that actually took place at the Big Thompson.

Boulder lies at the mouth of a canyon. Its main public buildings and its graduate student housing are all on the flood plain. If Boulder Creek had been flooded, it might have caused a thousand deaths and ten times the property damage. The chilling reflection is that one day, Boulder Creek will be flooded; we just don't know when. Similarly, San Francisco will one day be destroyed by an earthquake and New York City by nuclear explosion; we just don't know when.



How do we live with catastrophe? The flood at Big Thompson Canyon in Colorado last August is a tragic example of the randomness in nature that frustrates our desire for order, and our efforts to articulate order through science. (Photo: U.P.I.)

A Necessary Uncertainty

Living with catastrophe is the common lot of all humankind. The probability that any one of us will die today is very low. But we will all die; we just don't know when, and what is more, we don't want to know when. Irreversible catastrophe to this human body is a certainty, not a probability. The only uncertainty is the date. Death is the specter at every human feast, the fly in every human ointment.

We have learned to live with our mortality in many ways; accommodations to it are numerous in human history. There has been the hope of life after death: not many cultures are without it, though the hope is often vague and sometimes rather disagreeable. "For in that sleep of death what dreams may come," Hamlet says.

Another traditional consolation is fatalism: what will be will be. At worst, fatalism can lead to inertia and the failure to do even what can be done. At best, it may provide a realistic appraisal of the necessity for uncertainty — and an acceptance of that necessity. In our own society, the more common consolation is often simple denial: we refuse to think about death and when it occurs, we dress it up with such absurdities as embalming.

The nonlinearity and uncertainty of the real world raises problems in the scientific subculture and its view of the world. Scientists love both linearity and certainty, for only linearity and certainty enable us

to predict events. Even in nonlinear functions we seek linearity in the derivatives. Without some stability somewhere in parameters we cannot articulate a law; without a law, we cannot predict.

The scientist is uncomfortable with real randomness. Even Einstein could not accept the idea of a quantum jump or the Heisenberg principle because of his profound conviction that nature does not play dice. Belief that uncertainty represents ignorance, an ignorance we can cure with the salve of further knowledge, lies deep in the scientific enterprise. And scientists are not alone in this belief. The whole human race has a horror of randomness and a rage for order which are the sources of its superstitions — the perception of order where there is none.

The Evidence of Things Not Seen

The notion that true randomness might exist in the universe somehow threatens orderly minds, for it seems to put limits to knowledge which are as uncomfortable as limits to growth. Philosophically, of course, the question whether there is true randomness in the universe can never be answered. Fortunately, from the human point of view, the question need not be answered because all we are concerned with is uncertainty. Whether the limits of certainty are to be found in the nature of the human mind or the nature of the universe outside it does not matter very much. But the fact that there are limits to human certainty must be recognized. Irreducible uncertainty is a fact of life. Indeed beyond a certain point, we would not wish to reduce it. Who would really wish to know the date of his or her death! There are situations in which uncertainty is the only condition which makes life tolerable. It too follows the great law of the goodness parabola that too much or too little is worse than the right amount: the Aristotelian mean is nearly everywhere significant.

Does the passion for linearity and certainty then distort scientific enterprise? One suspects that it does, especially in the social sciences where the search in dark rooms for invisible parameters that do not exist goes on constantly. This is not to deny the importance of the search for parameters that do exist, for the reduction of uncertainty, and for the pursuit of linearity wherever it may be discovered. At a certain point, however, linearity and certainty always break down and leave us with faith, hope, and charity, believing where we cannot prove, hoping against hope, and extending the blind determinism of vulgar social science into the absurd but real world of social creativity and human benevolence.

Kenneth E. Boulding is Professor of Economics and Director of the Institute of Behavioral Science at the University of Colorado. He is a regular contributor to the Review.

Letters

Continued from p. 3

safety was kept in focus.

A rebuttal to Mr. Fuller's book, *We Did Not Almost Lose Detroit,* is available from Detroit Edison, 2000 Second Avenue, Detroit, Mich. 48226.

E. L. Alexanderson
Detroit, Mich.

Mr. Alexanderson is Director of Nuclear Engineering for Detroit Edison. — Ed.

Popular Mathematics

David F. Salisbury's article on the coming "popularization" of computing machines (*June, 1976, pp. 6-7*) emphasizes their ability to calculate and the need of the populace to understand the vagaries of calculation with respect to practical, everyday problems.

This seems to me a short-sighted focus on the elegance and subtleties of the underlying mathematics, which are really only the means to an end. At present, calculating machines are not sophisticated enough to be used by anyone but scientists and engineers, whose career disciplines and interests qualify them for this use. Ultimately, though, the larger market of the general populace will be better served by computing machines whose forte is information management.

Contrary to Mr. Salisbury's article, I am much more interested in (and frustrated by) balancing my checkbook (and the more sophisticated related problems of balancing my budgets, planning my savings, verifying the adequacy of my present withholding, recalling my tax data at year-end, etc.) than I am in his examples: estimating the amounts of paint needed versus application techniques and surface characteristics, or understanding the variances of miles-per-gallon calculations.

The distinction is between being interested in and good at programming (which is an excellent career but not necessarily an excellent lifestyle) and successfully operating in our complex society. Few people have the freedom, time, or resources to do both. We should develop user-oriented machines with lots of applications programs that allow the users to concentrate on managing and controlling their lives rather than programming their machines. To date, I have encountered few farsighted articles in the literature on this exciting (and inevitable) new opportunity.

Robert R. Beck
Sunnyvale, Calif.

Viking Team Looks to Visible Science for Budget Security

National Report
by
David F. Salisbury

Collecting dust in back rooms at the Jet Propulsion Laboratory in Pasadena and at the Martin-Marietta plant in Denver are most of the parts needed for a third Viking mission to Mars.

Many of the Viking team members who made the first successful landing on Mars look so effortless this summer would dearly love to put the hardware together, load a more versatile biology package onboard, put tractor treads on the lander, and launch it for the red planet in 1981.

Otherwise, architects and builders of the unmanned space program can look forward to a number of lean years. The planetary program has been squeezed between the rising development costs of the Space Shuttle and the spending ceiling Congress has maintained on the National Aeronautics and Space Administration (N.A.S.A.).

As a result, the space agency has only two unmanned missions in the works: a flyby of Jupiter and Saturn and a Venus probe. And most of the hardware for them has already been developed.

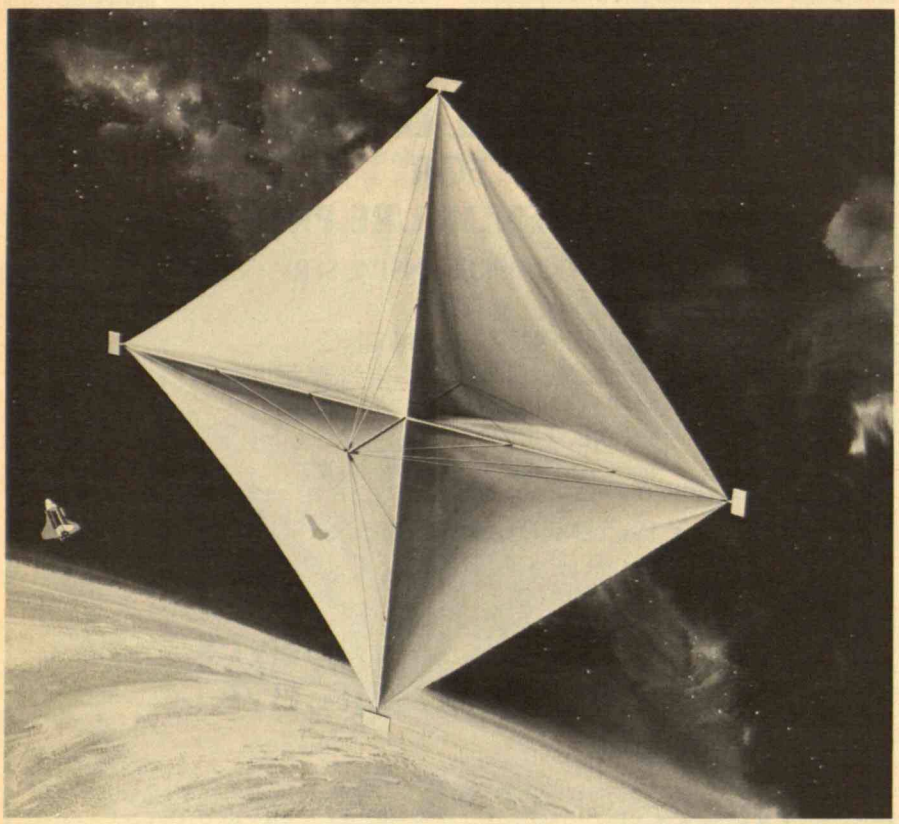
Many of the thousands of engineers and technicians who helped design and fabricate the billion-dollar Mars effort have already left aerospace. The Jet Propulsion Laboratory (J.P.L.) — like the rest of the industry supported by the unmanned program — faces further cutbacks.

But adversity, in this case, may be the mother of revelation. There are signs that the would-be planetary explorers may be waking up to a fundamental, if somewhat unpalatable, fact: there must be more in the program for the public if it is to be publicly supported at a level equal to its importance.

While the space agency and the enterprise it supports has given lip-service to this notion for some years, their ingrained attitude has been elitist. The engineers and scientists involved have been far more interested in pursuing goals they find interesting and exciting than in sharing the sense and significance of what they do with the public.

Evidence that this attitude is changing is the yeoman effort made by Viking project manager James S. Martin, Jr., and his deputies to supply photos, information, and sometimes reluctant scientists to the media. ("They tell us to perform and we perform," remarked chief biologist Harold Klein dolefully one morning. He had been up almost all night analyzing the latest data from the life detection experiments and was faced with interpreting them before an importunate press corps later in the day.)

As painful as some of this "instant science" has been for the scientists, it has helped the nation's science writers share some of the scientific adventure of the mission with the public.



One of the Viking team's "purple pigeons" — space missions designed to excite the public as well as the scientists — is this "solar sail." Its 500,000 square meters of reflective foil would shuttle through the solar system, blown by the radiative pressure of light. The sail is only one of the projects Viking scientists are proposing to ensure future space exploration. (Illustration: N.A.S.A.)

Purple Pigeons

Bruce C. Murray, once one of the planetary program's most eloquent purists, has not been ignorant of the science writers' contributions. Recently, Dr. Murray was appointed director to J.P.L. As a result, he was inspired to set up an ad hoc committee, locally known as the Skunkworks, to assemble a list of possible unmanned missions that combine good science and popular appeal.

By dubbing these "purple pigeons" and revealing them to select members of the national press corps assembled here for the Mars landing, Dr. Murray created a rash of publicity about the unmanned program's future.

A "Space Clipper" Moored to Imagination

The Viking missions to Mars may be the spectacular finale to a show that has no sequel. The national center for unmanned missions has scheduled only one other mission after Viking — a Mariner-Jupiter-Saturn "flyby," to be launched sometime next year and destined to reach Jupiter in 1979 and Saturn in 1981. Bruce C. Murray, the new Director of the Jet Propulsion Laboratory at California Institute of Technology (he studied physics at M.I.T in the Class of 1953) now fears for the future of space exploration.

Dr. Murray does not ascribe the dwindling of the U.S. space program to lack of public interest nor to the diminished fervor of the U.S.-Soviet space race. Although fictions of space odysseys proliferate, the key problem is that the machinery for their implementation has run dry. "We've had a failure of imagination (among space scientists) recently, and imagination is what space science thrives on," Dr. Murray told Robert Cooke, Science Editor of the *Boston Globe*.

So it was that an ad hoc committee to brainstorm new programs was organized at J.P.L. soon after Dr. Murray became director last year. To date the pièce de résistance of this "planetary Skunkworks" committee is a 500,000-square-meter "solar sail," a thin plastic sheet coated with aluminum, propelled by the radiation it captures from the sun and by the pressure of other light sources.

Astronauts aboard a space shuttle would unfurl and launch the sail by swinging it round and round its orbit, developing velocities up to 45 miles per second like a slingshot. The sail would be steered by three small vanes which would maintain its proper angle to the sun.

Dr. Murray foresees a pioneer "sail" orbit of the earth in 1979, and the sail can be used more than once — later as an interplanetary shuttle. For instance, in a follow-up mission to Mars, Dr. Murray hopes to have two pairs of robot rovers collecting samples of soil, rocks, or, if life is found, living organisms. The sail could ferry the samples back to earth.

Halley's Comet is destined to swing toward the sun in 1986. It could be met by a solar sail launched from earth which would "fly in formation" with the comet. The sail would be the means to discover the composition of comets, thinks Dr. Murray. "No one knows the mass or true size of a comet. But if we could get close to it, we could send a thruster out, grab some, then come back."

In the more distant future, Dr. Murray envisions that this "Yankee Clipper" sailing vehicle "would obviously be the way for people to travel through the solar system by the late 1990s." He estimates that a round-trip manned voyage to Mars would take about three years.

A public fascination for the search for life fueled the Viking program. But if this search proves futile, Dr. Murray will still consider the program a success. Space exploration helps us to find out who we are by extending our understanding of our own planet — particularly its origin, atmosphere, and magnetic field.

There are fruits of the space program in addition to its purely scientific contributions, so the program's costs cannot be weighed on a material scale. "Viking costs about as much as a fortnight of the Vietnam war . . . I find the comparison particularly poignant: life versus death, hope versus fear. Space exploration, and the highly mechanized destruction of people, use similar technology . . ., and [they require] similar human qualities of organization and daring. Can we not make the transition from automated aerospace killing to automated aerospace exploration of the solar system?" Dr. Murray asks.

The space program bolsters public morale and national pride, says Dr. Murray. "Americans feel that this is a good thing to do. People were confused by Vietnam and the energy crisis. But in this we can win. It's unreservedly good." — *S.F.*

Of course, N.A.S.A. has a number of similar "purple pigeons" of its own. But they are sitting in a file cabinet somewhere in Washington, D. C., awaiting the conclusion of Space Shuttle developement. And they have been chosen solely for scientific merit and technical feasibility.

Scientific committees have a stranglehold on planetary program planning and are squeezing all the vitality out of it, thinks Clarence Gates, the J.P.L. manager who headed the Skunkworks. The object of the Skunkworks study was to restore some imagination to the planning process, Dr. Murray told reporters.

Here are some of the J.P.L. "purple pigeons":

— Pairs of robot rovers, about the size of an office desk, which would remotely explore the Mars surface. They would have a lifetime of one year, travel 1,500 kilometers, and do the same things that the Viking landers are doing now.

— An orbital mission to unveil the hidden face of Venus with a radar-equipped satellite. The radar could image the planet's surface through the perpetual cloud cover with a resolution equal to that of the pictures Viking orbiters are taking of Mars.

— Development of a "solar sail." A 500,000 square meter expanse of reflective foil would sail about the solar system blown by the radiative pressure of light. It could rendezvous with Halley's comet in 1986 and serve as an interplanetary shuttle. Because of its large payload capability, the solar sail would make it possible to return soil samples from other planets.

— A grand tour of the Galilean moons of Jupiter. The moons form a miniature solar system around the giant gas planet. The mission would end with a landing on Ganymede, which is about the size of Mercury and is thought to have a water ice crust.

— Orbiting a mother/daughter spacecraft around Saturn at the radius of its moon, Titan. While the mother craft studies the planet's rings, atmosphere, and radiation environment, the daughter craft would land on the moon. Titan is known to have a methane-rich atmosphere and is one of Cornell scientist Carl Sagan's favorite places to hunt for life.

Selling Buck Rogers

A common denominator of all these missions is imaging systems to radio pictures from the exotic sites they visit. The superb pictures Viking has supplied of the Martian surface have been an important stimulus to public interest.

The price tags reported for these missions range from $200 to $400 million. But space agency sources criticize the estimates as unbelievably low. When questioned about them, Dr. Gates replied, "Oh, I don't put much stock in them. They are just horseback estimates."

The degree by which these figures are understated becomes clear when they are compared with the cost of using existing Viking parts for a follow-on Mars mission. According to a 1974 study at N.A.S.A.'s Langley Research Center, a third mission — identical to the first two and utilizing existing hardware — would cost $200 million in 1974 dollars. With an improved biology package and treads for mobility, the figure jumps to $320 million.

Continued on page 15

Toward a Non-Nuclear Future in a Nuclear World

Washington Report
by
Colin Norman

A world with a dozen or more nuclear powers would be a different and dangerous place. Yet military diversion of the already massive and rapidly growing international trade in nuclear reactor technology threatens just that possibility. Small wonder, therefore, that nuclear proliferation is attracting the attention of Congress, the administration, and independent arms control analysts.

Despite almost universal acceptance of the need to prevent the spread of nuclear weapons, there is little agreement on the means to achieve that end. The United States' nuclear export policies lack coherence and, indeed, have yet to be stated explicitly. And international agreement on some key issues in nuclear export control is minimal.

Is nuclear proliferation therefore inevitable? The next few years will provide the answer, and the U.S. could be an important, moderating influence.

International nuclear trade is increasing by leaps and bounds, driven by the escalating price of oil and by the fact that many industrialized countries engaged in domestic nuclear power programs are seeking foreign markets to make their investments pay off. For many years, the U.S. totally dominated the market, but its share has declined from 85 per cent before 1972 to about 42 per cent over the past three years.

Though the potential diversion of nuclear power technology to weapons production has always been worrisome, it has blossomed into a major political issue because of two crucial events. The first was India's explosion of an atomic device on May 18, 1974. Produced from plutonium extracted from the spent fuel of a Canadian-supplied research reactor, the Indian explosion marks the first time that a nation used imported nuclear technology to join the nuclear club. The second event was the signing of a multibillion dollar deal between West Germany and Brazil that will eventually give Brazil an entire fuel cycle — including a uranium enrichment plant, power reactors, and a fuel reprocessing plant. The deal differs radically from previous nuclear trade agreements in its inclusion of enrichment and reprocessing plants, both of which can be used to produce weapons-grade nuclear materials. More recently, France has signed an agreement with Pakistan which also involves the sale of a reprocessing facility.

Nuclear Accounting

There are several reasons why the transfer of enrichment and reprocessing plants should be troubling. But first, it is worth examining the safeguards that are usually applied to nuclear exports to prevent diversion of nuclear materials to military use.

An agreement involving simply the sale of a reactor is relatively easy to safeguard, provided strict control is applied to the fuel passing through the reactor. Most reactors are fueled by uranium which is slightly enriched by boosting the concentration of the fissionable isotope uranium-235 from its natural level of about 0.7 per cent to about 2.7 per cent. Weapons-grade uranium is about 95 per cent uranium-235, so the raw reactor fuel presents little worry. Similarly, spent fuel rods cannot be converted directly to weapons when they are removed from a reactor. Although the rods contain some plutonium, a potential bomb ingredient, the plutonium must be separated from other intensely radioactive materials by chemical reprocessing before it can be used to make a bomb. Thus, provided a strict account is kept of the fuel entering and leaving the transferred reactor, and provided the spent fuel is not reprocessed by the purchasing country, there's little chance of diversion.

Usually the accounting is done by the International Atomic Energy Agency (I.A.E.A.), a Vienna-based organization. The I.A.E.A. keeps detailed records of all reactors under its supervision, and has a number of inspectors who make on-site checks to ensure that nonproliferation agreements are kept.

In theory, enrichment and reprocessing plants can also be safeguarded by keeping strict account of materials flowing through them. But the problems are great. For one thing, it is possible to use an enrichment plant to enrich uranium to weapons-grade levels. And for another, even if a reprocessing plant is operated under I.A.E.A. safeguards, it would be possible for the country operating it to build a plutonium stockpile which in an emergency could be converted rapidly into weapons. In other words, a reprocessing plant places a country only half a step away from membership in the nuclear club.

An (In)credible Response

The U.S. has been trying to deter international trade in enrichment and reprocessing technology. American companies, for example, are forbidden to sell such facilities abroad. But the Germany-Brazil and France-Pakistan deals have gone forward despite American opposition. To be sure, both Germany and France insist they are applying safeguards to their proposed contracts which will be more strict than those generally applied to nuclear exports. But the agreements clearly put nuclear transactions on a new footing.

Official American objections to the agreements were expressed behind the scenes. The chief forum which the U.S. has chosen to express its disapproval has been a series of secret talks, held in London over the past year, among representatives of several present and potential nuclear exporting countries.

The U.S. representatives tried in those talks to win an agreement to halt the transfer of enrichment and reprocessing technology, at least until more satisfactory safeguards have been worked out. But though considerable progress was made toward a general acceptance of the need to control nuclear exports, no agreement was reached on a moratorium on reprocessing and enrichment sales.

The American view did not prevail for several reasons. To begin with, some European governments are suspicious of the United States' motives, believing that the drive to stop trade in enrichment and reprocessing technology is designed as much to protect America's commercial interests as to prevent nuclear proliferation. American companies were competing with German and French concerns for the reactor orders from Brazil and Pakis-

tan, and lost the orders partly because the German and French concerns offered enrichment and reprocessing plants as "sweeteners" to secure the contracts. From Paris and Bonn, therefore, the United States' attempt to put the lid on such deals looks suspiciously like a move to prevent American companies from being undercut in the international market.

International suspicion can only be increased by the administration's reluctance to take a strong public stand on nuclear proliferation issues, and by its failure to write the strongest possible safeguards into agreements involving the sale of American reactors and technology. Though the German and French sales met the harsh condemnation of individual senators and congressmen, for example, the administration raised barely any public objection. Similarly, there was little official public outcry over India's reckless explosion. Certainly, the administration didn't emulate Canada's example of cutting off further nuclear assistance to India, even though it became known that American-supplied heavy water was used in the reactor in which the Indians produced their plutonium.

Moreover, the chief American argument for a moratorium on sales of reprocessing plants is being undercut by developments in the U.S. Essentially, administration officials have been arguing that since reprocessing is not yet economic, there's absolutely no reason for nations newly embarking on nuclear power to rush into it. Fred Iklé, Director of the Arms Control and Disarmament Agency (A.C.D.A.), noted in a talk to a United Nations conference last May, for example, that separating plutonium from spent fuel and recycling it as a reactor fuel "could replace at most about one-third of the fuel required ... Hence recycling would not bring independence from imported fuel." He added, "before we plunge into a plutonium fuel economy, let us look very closely at the risks and our ability to control them ... spreading plutonium should be avoided if possible, and with the current generation of reactors it can be avoided at no economic cost."

The trouble is, however, that the American nuclear industry is applying for a license to begin reprocessing commercial nuclear wastes in the U.S. because it believes that reprocessing is essential to the long-term economic viability of nuclear power. So again, American arguments seem to ring hollow in European capitals.

At Loggerheads with Industry

Given its failure to secure a moratorium on exports of reprocessing and enrichment technology, how should the U.S. proceed? Clearly, international negotiations among nuclear exporting countries should continue. Progress on many issues has already been made, and there are problems which still require attention: among them, strengthening the I.A.E.A. safeguards and inspection system. And there are several domestic policies which should also be overhauled.

On international questions Victor Gilinsky, a member of the Nuclear Regulatory Commission (N.R.C.), has demonstrated special wisdom. The N.R.C. has a statutory responsibility to determine whether or not proposed nuclear exports are "inimical to the common defense and security," and Gilinsky has dissented from two of its opinions when he felt the Commission had no such assurance.

The first involved a proposal to sell a nuclear reactor to Spain. Three of the N.R.C. commissioners approved the sale, arguing that because the reactor would be placed under I.A.E.A. control, it would be adequately safeguarded. Mr. Gilinsky was worried, however, because Spain has not ratified the Nuclear Non-Proliferation Treaty (N.P.T.), an international agreement which binds signatories not to develop nuclear weapons. Mr. Gilinsky argued that the U.S. should require the reactor to use only U.S.-supplied fuel, and so be subject at all times to U.S. controls, in addition to those of the I.A.E.A. The U.S. would then retain the right to veto reprocessing of the fuel, or, alternatively, to buy back the spent fuel. That concept could be applied usefully to all reactor sales to countries which have not signed the N.P.T.

As for domestic reprocessing, nonproliferation objectives should be considered when the N.R.C. decides whether to allow the U.S. nuclear industry to go ahead with reprocessing and plutonium recycle. The N.R.C. would be prudent to delay its decision at least until the feasibility of establishing multinational reprocessing centers has been examined. Such centers, which are being discussed as an alternative to a total embargo on sales of reprocessing plants, were proposed last year by Secretary of State Henry Kissinger. Though the idea is not universally endorsed by arms control analysts, it merits close attention. In any case, a decision by the U.S. not to go ahead with reprocessing and recycle at this time would send the message that the economics of the enterprise are not compelling.

Although extra restrictions on nuclear exports and denial of domestic reprocessing and plutonium recycle would be opposed bitterly by the nation's nuclear industry, the benefits to nonproliferation would far outweigh the economic costs. And in any case, the time has come for the U.S. to take a firm stand.

Colin Norman is Washington Correspondent for Nature *and a regular contributor to* Technology Review.

Genetic Engineering: Threat and Promise

Special Report
by
Diana M. Schneider

The controversy over "genetic engineering" — the question of recombinant molecules and their impact on science and society — has raged for the past two years in the corridors of academe and the National Institutes of Health. This summer it brought to M.I.T.'s Kresge Auditorium a standing-room-only audience of leading scientists in the field of genetics and immunology of all persuasions — including members of Science for the People, a group outspoken in its advocacy of the social implications of science. Reporters from many of our largest newspapers joined them. What was all the fuss about?

The conference — "The Impact of Recombinant Molecules on Science and Society" — was sponsored by Miles Laboratories as the tenth in its series of annual symposia on topics in molecular biology. It was a significant event in the stormy history of recombinant research, the first public occasion to deal systematically with all aspects of the field.

The term "recombinant molecules" refers to the bits of DNA scientists have learned to insert into the genetic material of cells. The field of molecular biology has been advanced by a number of critical discoveries in the past few years. Now, as Roland Beers of Miles Laboratories noted in his opening remarks to the symposium, "molecular biology is on the threshold of becoming a technology." But the future of this new technology has begun to trouble many scientists as they become aware of hazards that may counterbalance the benefits.

A Biochemical Factory?

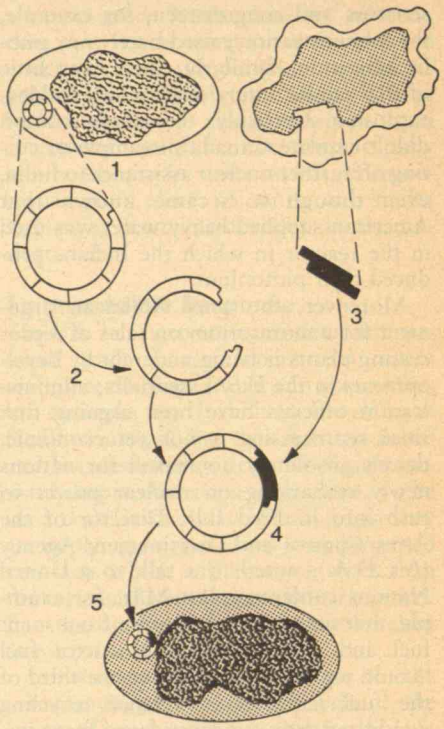
Three major advances in DNA technology have made possible the sophisticated manipulations of genetic material going on in laboratories today.

The genetic engineer first had to be able to break genetic material apart at highly specific sites. This problem was solved by the discovery of enzymes known as restriction endonucleases, which, in nature, protect cells from foreign genetic material, such as that of viruses. The enzymes protect a cell by taking apart the invading DNA without harming the DNA of its own organism.

The genetic engineer must also be able to splice his chunk of genetic material into another DNA strand, and this was made possible by the development of chemical and enzymatic techniques for joining segments of DNA.

Now comes the crucial part. Methods for cleaving and splicing DNA strands to create new genetic arrangements would be useless without some way to introduce the new materials into a living cell — recombining — without damaging the cell. Stanley Cohen of Stanford University developed such a method, and genetic manipulation became at least theoretically possible. Now, for example, the engineer might build a "biochemical factory" for rapid and inexpensive production of insulin by inserting the gene coding for insulin into a bacterium's genetic material, and then inserting this engineered material into the bacterial cell. This new bacterium would multiply and produce an appropriate supply of valuable insulin.

The positive benefits promised by the new techniques — recombinant DNA — are obvious. But there is potential to wreak biological havoc. The best bacterial candidate for genetic experimentation is *Escherichia coli,* about which more is known biochemically than of any other organism. Since *E. coli* is also the main bacterial inhabitant of the human gut, a number of frightening scenarios suggest themselves. For example, could an *E. coli* strain carrying all or part of a cancer-producing virus colonize the human intestine? Would it then spread and engender a cancer epidemic? In 1972, smallpox became epidemic in London when infectious material escaped from a research laboratory; the incident is only one indication of the inadequacy of normal physical containment procedures.



Biologists have learned to insert bits of DNA — recombinant molecules — into the genetic material of cells, opening new vistas for genetic research. The techniques are illustrated above: 1) A simple chromosome, called a plasmid, is isolated from a bacterium. 2) The plasmid's molecular ring is broken open. 3) A chromosome segment, containing genetic instructions, is split off from the donor cell of a higher organism. 4) The chromosome segment is inserted to complete the plasmid ring. 5) The new chromosome is put into a fresh host bacterium where it can generate entirely new substances. (Chart: *Business Week*)

Containing the Hazard

Nervous about the dangers of the new research, the Committee on Recombinant DNA Molecules of the National Academy of Sciences wrote an open letter to *Science* in July, 1974, calling for a self-imposed moratorium on recombinant DNA research. The ban would be effective "until the potential hazards of . . . recombinant DNA molecules have been better evaluated, or until adequate methods are developed for preventing their spread" (*see October/November, 1974, pp. 75-76*).

Then in March, 1975, a group led by Paul Berg of Stanford University and David Baltimore of M.I.T. organized a conference at Asilomar (California) to review developments in the field and to dis-

cuss ways of dealing with the potential hazards. After four days of discussion and heated argument, a consensus was reached and the self-imposed ban on research was lifted; it had been observed for nearly 18 months. In its stead, general guidelines were adopted permitting certain experiments, deferring others until safer containment procedures could be developed, and all but banning still others considered highly dangerous. But enforcement rested solely on peer pressure, without force of law.

The guidelines developed at Asilomar recommended that the degree of physical containment match the experiment's presumed hazard. For experiments of greatest risk, facilities were proposed similar to those required for work with highly infectious agents of disease, with isolation by air locks and negative pressure, a requirement for clothing changes and showers, and treatment systems to remove contaminants in exhaust air and liquid and solid wastes.

In addition to these extrinsic precautions, biological containment methods were advocated, among them genetically crippling organisms to make them unable to survive outside a carefully controlled laboratory environment.

Several conferences followed Asilomar at which scientists struggled to draft still more restrictive guidelines. And finally in December, an advisory committee to the National Institutes of Health met in La Jolla, Calif., and agreed upon strict regulations to control recombinant research supported by N.I.H. grants and contracts. These were formalized into guidelines and issued late in June, 1976; they will undoubtedly be the basis for international controls as other countries come to face the same problem.

In briefest summary, the advisory committee recommended and the guidelines require that DNA from highly pathogenic organisms not be cloned at all, and that genes producing highly toxic substances, such as that for diphtheria toxin, not be spliced to other DNA.

Meanwhile, the Asilomar guidelines had been at work: in December, 1975, Roy Curtiss of the University of Alabama succeeded in developing a crippled strain of *E. coli,* which he named "χ 1776." It meets all the criteria urged by the scientists who met at Asilomar and has the added advantage of being unable to survive in the human gut.

All through the spring, scientists — heartened by the N.I.H. regulations and the creation in N.I.H. of an Office of Recombinant DNA Activities — debated if and how research on recombinant DNA might proceed. Several distinguished biologists, among them Erwin Chargaff of Columbia University and Robert Sinsheimer of California Institute of Technology, urged caution, suggesting that research be confined to a single high-containment facility such as the biological laboratories at Fort Detrick, thus minimizing damage should a breakout occur. Science for the People responded by observing that there have been 423 cases of infection and three deaths at Fort Detrick during the past 25 years.

The Miles-sponsored symposium met at M.I.T. in a highly-charged atmosphere just two weeks before release of the final N.I.H. Guidelines on Recombinant Research. In his opening remarks, Walter Ames Compton of Miles Laboratories took the positive view: "DNA is the molecule of heredity. To know its structure and method of duplication enables us to know how genetic directions are written and transmitted, how the forms of life are ordered from one generation to the next. Through this, we may now have the tools for enormous benefits to mankind.

"For example, if genes that code for nitrogen fixation with symbiotic bacteria could be introduced and made to function in ... crops ..., the benefits

Genetic Engineering in the Middle of a City?

Early in June the Boston *Phoenix,* a local "alternative" weekly, published an article outlining Harvard's plan to build a moderate risk (P3) laboratory on the fourth floor of its Divinity Street biology building. Some, but not all, of the experiments to be conducted in the proposed facility involved recombinant DNA, experiments subjected to severe examination in recent years by the scientists conducting the research and by the National Institutes of Health. Cambridge harbors some of the most vocal proponents and detractors of the research, many of whom are affiliated with Harvard and M.I.T.

The *Phoenix* article was brought to the attention of Cambridge's Mayor Alfred E. Velluchi, who had not been previously informed of Harvard's intent to conduct experiments of this nature in the geographical middle of his constituency.

The location of the proposed laboratory is on the same floor as the office of Ruth Hubbard, a Harvard Professor of Biology, who objects to the laboratory's location and its intent and who had alerted City Council members to her concerns. City councilor Barbara Ackermann put Dr. Hubbard in touch with Mayor Velluchi, and as a result a hearing was scheduled at Cambridge City Hall on June 23.

Unsolicited comments, both for and against the research, poured into the Mayor's office prior to the hearing. Most lauded Cambridge's attempt to involve the public in an issue which has historically, and perhaps by default, been left to scientists.

The June 23 meeting drew proponents and opponents of the experiments from Cambridge's research elite — among them Nobelist George Wald of Harvard (against) and Nobelist David Baltimore of M.I.T. (for). Controversy among these representatives worried the city councilors. The Mayor announced that he intended to introduce a motion to ban recombinant research in Cambridge altogether at the next City Council meeting two weeks hence. Although the debate was long and circuitous, it had substance and made some issues apparent:

— What should be the public's involvement in decision-making on controversial scientific research?

— What constitutes reasonable safety in the face of unknown risk (possibly great and just as possibly minuscule)?

Progress of a sort was made at the next City Council meeting on July 7. Mayor Vellucci withdrew his proposal for a two-year moratorium, to the relief of many scientists. Instead, a voluntary, "good faith" ban on the research involving recombinant DNA at sophisticated levels was passed. More to the point, a Laboratory Experimentation Review Board, composed of townspeople uninvolved with the direct consequences of a decision on DNA research, was established. The Board will advise the City Health Commissioner, who has final responsibility to resolve the question.

At the end of the July 7 meeting, councilors were focusing on the issue's politics rather than its scientific implications. Most apparent was the need for more communication between the scientists who perform research and the public who fund it — and who must suffer the consequences of any "accident." While scientific assessment is not the City Council's responsibility, the councilors are insecure about diverting responsibility for the research solely to the N.I.H., which released its long-debated Guidelines on Recombinant DNA Research the day of the first Cambridge hearing.

As of this writing, the review board has yet to reach a decision. While indications are that recombinant DNA research will not be interrupted, it does seem likely that the city will keep a sharper tab on the two giant research centers within its boundaries. And, in the meantime, Harvard is going ahead with planning for its new laboratory.

— *S.J.N.*

would be immense to a world that is short of food.

"If the genes that code for the synthesis of vitamins, antibiotics, or hormones can be made to function in microorganisms, then bacteria which can be grown in large quantities in the laboratory could be used to produce these precious materials. This would be much simpler and less expensive than the methods used by the pharmaceutical industry today.

"Five per cent of the population suffer from certain genetic diseases — such as cystic fibrosis, diabetes, and sickle cell anemia — which may, in time, be amenable to genetic engineering.

"In short, biologists have found themselves equipped with molecular tools which confer on them profound powers. In the last two years molecular biology has reached a stage that is brilliant with promise — and danger."

The scientific sessions at the conference were devoted to crucial areas of recombinant research. Technical presentations were devoted to recent advances in the technology of gene manipulation: the use of restriction endonucleases and other enzymes to cleave and rejoin DNA, the construction of safer strains of *E. coli*, and the development of appropriate "vectors" — carriers of the experimental material, which now include viruses and "plasmids" (small rings of DNA found in many bacteria). Since many of the most exciting possible results of recombinant research are in the area of plant genetics, an entire session was devoted to this topic.

But the session of greatest general interest was devoted to the social impact of recombinant research, with papers ranging from the probability of infestation of the human gut by modified *E. coli* to the role of regulatory agencies in the field.

Mark Richmond of the University of Bristol reported that a laboratory strain of *E. coli* known as K-12 colonizes the gut only poorly, and ingested *E. coli* disappear completely within a few days. But if the person involved had been treated with tetracycline, newly-available, tetracycline-resistant laboratory strains were able to "take root" quite well. The conclusion is that no one being treated with antibiotics should work with recombinant materials. (It is factors such as this, which could easily pass unnoticed, that make one apprehensive about such experimentation.) Dr. Richmond also presented evidence suggesting that portions of the genetic material of ingested bacteria can be transferred to other bacteria in the gut, and on this basis he urged that containment procedures not be relaxed even with weakened strains such as "χ 1776"; we simply do not know what potential exists for DNA transfer in the gut when the host cell has died.

Other papers proposed the existence of complex interrelationships of genetic materials and viruses, many of them not fully understood; and Seymour Lederberg of Brown University summarized by warning that there are major hazards to be dealt with and that no containment procedure can be perfect. So the question remained without consensus: Will the benefits outweigh the risks?

In a position paper representing Science for the People, Frances Warshaw, a graduate student in the M.I.T. Biology Department, cautioned against proceeding with recombinant research until we have satisfied ourselves that we can perform such experiments in complete safety.

Fearsome Power

Introducing the conference, Dr. Beers had suggested a philosophical basis for much of the apprehension with which recombinant DNA technology has been greeted. "Knowledge provides the basis for control over the present and the future — that is, power. Yet, because knowledge is often incomplete, so is the power it provides, hence the source of the uncertainty . . .

"The proponents of moratoriums on research for the purpose of restricting knowledge about man and his universe and the direct attacks on technological change are to be recognized as human responses to the fear of the unknown; but implicit in this response is a distrust of the human intellect to perform adequately toward the threatened risks.

"Compounding and confusing society's response to the new technology is its over-simplified belief that a technology can solve a major social problem without regard to the institutional and behavioral changes that must ultimately occur. . . . Any technology, including genetic engineering, designed to increase the productivity of the earth can do no more than buy the time necessary for man to discover and design the proper solution of institutional and behavioral reform to obliterate the underlying cause, namely, unlimited growth. If genetic engineering is to be used to continue this treadmill of mankind, where its objective is directed toward quantity rather than quality of life, then the tragedy of man lies in the contrast between the genius of his intellect to develop a technology as brilliant and beautiful as genetic engineering and the goals to which that technology is applied.

"It is analogous to the contrast between the marvels of a color television system and the usual programs displayed on a TV screen. Yet, the analogy is not entirely appropriate. For in buying time, this new technology introduces an additional cost. If during this interim period a solution is not found and implemented, the magnitude of the ultimate catastrophe by virtue of the numbers of mankind involved will be even greater than if the technology had not been developed."

Dr. Schneider is Senior Editor for Raven Press; formerly, she was staff scientist with the Neurosciences Research Program of M.I.T.

Book Review

Computers and the Artificial Intelligentsia

Computer Power and Human Reason
Joseph Weizenbaum
San Francisco: W. H. Freeman and Co., xii + 300 pp.; $9.95

Reviewed by John Crocker

Philip Morrison, Professor of Physics at M.I.T., recently compared the metaphors of natural theology, which rationalized and interpreted the world of nature, with the new computer metaphors of today. These new metaphors have emerged from mathematics and electronics and presume to simulate and explain the whole range of human activity. Neither metaphor, he said, has been "willing to constrain itself to that subject matter in which it is deeply involved, but sees in itself a model for much of everything else." The computer metaphor, he says, claims to "account for almost any process by mapping it somehow onto a machine. You might call this Natural Computerology."

Both metaphors have claimed near-universal validity and have had, each in its own time, the potential to make that claim good in the popular imagination. And both are essentially matters of faith, not science: they can be neither proved nor disproved empirically.

Computer Power and Human Reason combines expert technical analysis and deep humanistic insight to demystify the pretensions of the computer metaphor for the lay person and the expert alike. While affirming the remarkable effectiveness and considerable value of computers as symbol-manipulating machines, Dr. Weizenbaum's argument is a passionately reasoned warning that no single metaphor (whether scientific, philosophical, religious, or any other) can adequately account for all of reality. No single perspective ought to be universalized, and whenever one is, we are led astray.

Dr. Weizenbaum's book is a moral and philosophical attack on the "imperialism of instrumental reason," a rationality that reduces every issue to a technical problem for which there must exist a technical solution. He argues persuasively for the essential and irreducible difference between human beings and machines. He takes the computer — his field of study and practice for 25 years — as a near paradigm of that thesis. The computer serves as a vehicle for Dr. Weizenbaum's argument, for through it he interprets science, technology, and their relations to human beings and culture.

Each chapter is a unit and could stand alone. Each one adds to the argument, not in a linear fashion, but more as spokes around a hub which, by the book's end, complete a wheel. In most chapters, Dr. Weizenbaum explains for lay persons some technical aspect of the computer and sets the computer's limits, tells us why these limits exist, what the computer specialists believe, and what is ethically and philosophically problematical about their beliefs.

The book is hard going for people like myself who must struggle with technical explanations, and for those who are not philosophers and find ethical and philosophical argument difficult. But Dr. Weizenbaum is a consummate teacher who expects his students (and they include his readers) to understand each step thoroughly. If we pay him the attention he expects and deserves, he does make us understand.

Computer Language

The "artificial intelligentsia," as he calls his colleagues in the field, cannot dismiss Joseph Weizenbaum along with Lewis Mumford, Daniel Callahan, and other humanist critics as a "mere" philosopher. He is one of their own who knows as much computer science as they do; he unpacks and challenges their assumptions, carefully dissects their claims, and presents them for public perusal and criticism.

The origins of this important and challenging investigation lie in Dr. Weizenbaum's shock at people's persistent misunderstanding of a computer program for processing natural language which enables conversation with the computer in English. He called it ELIZA after the heroine of George Bernard Shaw's *Pygmalion*. The program was set up to play a game called DOCTOR; that is, to parody the responses of a Rogerian psychotherapist who encourages and draws out a patient during a first interview. The patient types comments or questions at DOCTOR's console, and DOCTOR types out non-directive replies.

Dr. Weizenbaum found that people became emotionally involved with DOCTOR almost immediately, and treated the computer as a person who could understand and respond with appropriate care and sensitivity. His secretary, who knew the realities as well as any lay person could, once asked him to leave the room so she and DOCTOR could converse in private. Some psychiatrists even seriously suggested the use and value of DOCTOR in actual psychotherapeutic practice!

Simulated Wisdom

Why should people insist on confusing a machine's technique of information processing with the human empathy of a caring therapist? Lay people, Dr. Weizenbaum argues, misunderstand what the computer does because they do not know how it works. "Unless they are capable of very great skepticism. . .," he writes, "[untrained people] can explain the computer's intellectual feats only by bringing to bear the single analogy available to them, that is, their model of their own capacity to think." The tricks which programs can be made to do are too complex to suggest their real emptiness. So we anthropomorphize the computer and computerize ourselves: we come to believe that our brains are merely complex organic computers. The next step, then, easily follows: we are tempted to yield our autonomy as free and responsible persons to the "autonomous" machines.

Many computer scientists are more than tempted; they are true believers. They argue that human beings and computers are merely "two different species of one abstract genus called 'information processing systems.' " Dr. Weizenbaum

vigorously denies such assumptions. Any theoretical explanation which so categorizes people with machines is bound radically to distort human reality. In fact, human beings and computers are so profoundly different that any claims about one applied to the other are bound to mistake the essence of both.

Take only one issue as an example: natural language simulation. The artificial intelligentsia believe they are approaching a general theoretical understanding of natural language that can be programmed. To this claim, Dr. Weizenbaum lays four charges: First, there are ideas which no machine will ever understand because they relate to human problems and objectives inappropriate to machines. Second, the assumption that a theory of language can be verified simply by programming it confuses demonstration with proof. Third, computer programs can correctly simulate natural language in part, but not necessarily with theoretical accuracy: "Imagine an adding machine that adds some but not all numbers correctly, and about which we cannot even say what characterizes the numbers it can add. We would hardly call that the mechanization of arithmetic." And fourth, while agreeing that a machine might "understand" — appropriately answer — the sentence, "Will you come to dinner with me this evening?", could it "possibly understand that sentence to mean a shy young man's desperate longing for love"?

To simulate is in no full sense to understand or to explain. In fact, computer "understanding" and so-called intelligence must, he believes, always be "alien to genuine human problems and concerns."

Ethics and Lost Keys

Dr. Weizenbaum's arguments do not seem relevant to the computer specialist and the author knows why. The specialist is like the drunkard who has lost his keys in the dark, but who looks for them only under street lamps because that is where the light is.

The specialist's attitude toward language simulation illustrates the point: "A theory [embodied in a computer program] purports to describe the conceptual structures that underlie all human language understanding. [These structures are the lost keys.] But the only conceptual structures it admits as legitimate are those that can be represented in the form of computer-manipulable data structures. [Here is the street lamp.] These are then simply pronounced to constitute all the conceptual structures that underlie all of human thought. [There are no keys to be found except under the light.] Given such a program, i.e., such a narrowing of the meaning of the word 'all,' it should indeed be possible to prove that the theory accounts for 'all' human linguistic behavior.

"A theory is, of course, itself a conceptual framework. And so it determines what is and what is not to count as fact. The theories — or, perhaps better said, root metaphors — that have hypnotized the artificial intelligentsia, and large segments of the general public as well, have long ago determined that life is what is computable and only that."

No countervailing evidence, then, can be allowed. The theory is completely protected by "cyclical elaboration": that is, "the programmer is free to convert every new embarassment into a special case to be handled by a specially constructed, ad hoc subprogram and to be thus incorporated into the over-all system." Here is an absolutely enclosed, self-validating, unfalsifiable system which, within its own circle of assumptions, can explain any conceivable event.

Dr. Weizenbaum reminds us of the direct parallel between this perspective and the equally self-enclosed behaviorism of B. F. Skinner. The person as an initiating creative agent is declared irrelevant to human behavior: that set of keys is in the dark, beyond the light under the lamppost, and is inaccessible to the theory. So the artificial intelligentsia simply redefine the human being as a computer.

Faced with this sort of circular and invulnerable thinking, Dr. Weizenbaum comes to his major point: "*The relevant issues are neither technological nor even mathematical; they are ethical.* They cannot be settled by asking questions beginning with 'can.' The limits of the applicability of computers are ultimately statable only in terms of *oughts.*"

Thus to ask, " 'What does a judge (or a psychiatrist) know that we cannot tell a computer?' is a monstrous obscenity." For "we come to know and understand not only by way of the mechanisms of the conscious. We are capable of listening with the third ear, of sensing living truth, that is. . . truth beyond any standards of provability." That sort of truth is a matter of wisdom, a kind of understanding computers neither can nor should be presumed to comprehend. Computers "may even be able to arrive at 'correct' decisions in some cases — but always and necessarily on bases no human being should be willing to accept."

Matters of Faith

So ethics are the ground of this final appeal against "the imperialism of instrumental reason" — in a culture which has lost its ethical roots! Not only among modern intellectuals but in the modern popular wisdom, the canons of positivism are almost universally believed: namely, that science is the sole arbiter of what is real and true, that ethical questions are matters of opinion, and that therefore, one ethical opinion is as good as another. The ancient metaphysical realities of justice, equity, beauty, happiness, and love — all once upheld by faith or reason or both as transcendent objective realities under which we all stand and to which we

are all accountable — have now been reduced in the name of science to matters of subjective taste or custom. Human life is thus bereft of every meaning which transcends it.

The human being is denied personal autonomy and is reduced to animal energy. We become organisms in an environment, largely determined — so we are told — by internal genetic and external social forces, and capable of being simulated and one day replaced in many of our functions by computers. Not a pretty picture, but one to which the computer metaphor contributes, and one against which Dr. Weizenbaum sets his fervent intelligence.

In his last chapter, Dr. Weizenbaum explains what he believes it means to be authentically human. To begin with, the essence of a human act, as opposed to a mechanical act, is its intent, done "because I choose to" and not "because you tell me to." Choosing freely is central. But beyond that, we must understand that it is the moral, not the instrumental, justification which makes an act genuinely human. "When instrumental reason is the sole guide to action, the acts it justifies are robbed of their inherent meaning and thus exist in a moral vacuum." By contrast, "the good of a moral act inheres in the act itself. That is why an act itself can ennoble or corrupt the person who performs it."

For this reason we have a moral responsibility to resist "the various forms of human and social engineering," including computer manipulation, which dehumanize us by intentionally "circumventing all human contexts, especially those that give real meaning to human language," human action, and human life.

John Crocker is Episcopal Chaplain of M.I.T. and Chairman of the Steering Committee of M.I.T.'s Technology and Culture Seminar.

Salisbury

Continued from p. 7

The Mars landing seems to have caught the public's interest more than any space event since the first landing on the moon. Whether this will translate into more money for planetary exploration given an uncertain national economy is not clear. But serious consideration of the popular interest during mission planning will increase the chances for a larger budget.

As Dr. Murray says, "These projects will have to sell themselves. Either we will capture a renewed spirit of imagination or the (unmanned) space program will go down the tubes."

David F. Salisbury is Science Editor of the Christian Science Monitor *and writes regularly for* Technology Review.

Trend of Affairs

Trends This Month

To Hire or Fire: The Case of Women in the Workplace

Consumer advocates are scrutinizing everything from automobiles to pesticides. Workers who may be subject to on-the-job hazards are now under the magnifying glass. But anomalies and frustrations abound.

For example, although federal occupational safety and health legislation passed in 1970 is designed to insure all workers the right to a healthy and safe workplace, the science required to understand and fulfill that commitment is often lacking; informational bottlenecks frustrate the setting of standards and enforcement, and the goals of laws protecting equality of opportunity are not coordinated with those protecting worker safety.

Even working conditions normally taken for granted pose subtle risks:

— Flight attendants' working hours disrupt biological rhythms, including sleep and, among women, menstrual cycles, says Sunny K. Wofford of the Association of Flight Attendants. And the 3° to 4° incline of the aisle in large jetliners poses a fatiguing work environment for them.

— Cosmetologists who inhale large quantities of hair spray increase their risk of developing chronic respiratory disease. The workers in small salons — which tend to be poorly ventilated — are most at risk, a Utah survey by the National Institute for Occupational Safety and Health (N.I.O.S.H.) reports.

— When the suicide rate among dentists was reported to be greater than that among other professionals, California dentists asked for an investigation. Mercury poisoning, known for its effect on behavior and the nervous system, was a prime suspect. All dental offices are contaminated with mercury, reports Meier Schneider of the Medical Services Division of Los Angeles. The highest exposure occurred among dental assistants who prepared the mercury-silver amalgam used in dental restoration.

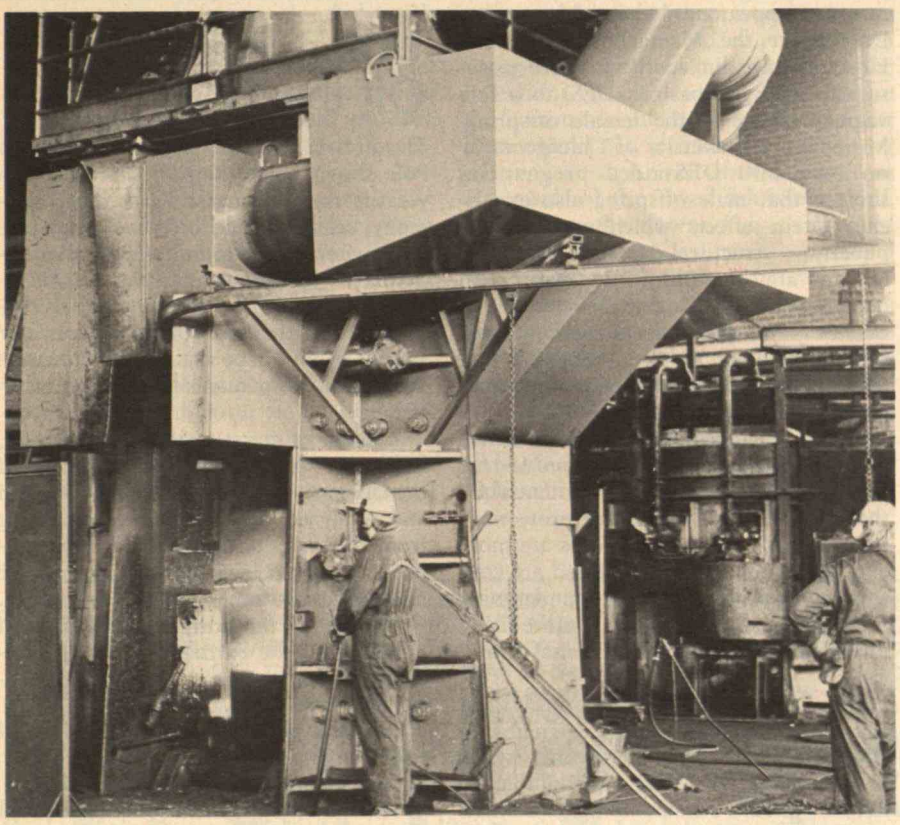
These accounts were among those heard when researchers, physicians, managers, and workers assembled last summer in Washington for the Conference on Women and the Workplace held by the Society for Occupational and Environmental Health. The goals of the participants did not always mesh. Workers and lay delegates assailed the scientific community for belaboring them with technical detail and for emphasizing methodology instead of discussing their findings' social impact. Scientists, on the other hand, advised against propaganda and alarm, calling for a more careful translation of information from laboratory to layperson. Their one agreement: change is needed, and it is proceeding too slowly.

Survival of the Superworker

The worker who is not physically matched to the job is a good candidate for disability. For example, the highest rate of injury among workers who lift heavy loads occurs among those who simply aren't built for the task, says Don Chaffin, Director of the Occupational Health and Safety Engineering Program at the University of Michigan.

But once the worker is deemed "fit" for the job, must an industry guarantee continued employment? Should a worker who has suffered a heart attack be fired? If heart-attack-prone, should he or she be hired in the first place? Should a worker's heart condition be ignored, or the job modified to minimize risks and keep the worker employed? Substitute pregnancy in the above questions: should a company fire a pregnant woman, not hire women at all, ignore risks to mother and fetus, or clean up a dirty workplace? If the answers are different, then sexist employment practices may be at root.

Other countries have had to deal with the problem of worker's individual susceptibility. In Scandinavia and the Soviet



Face plates and ear plugs were not enough to protect workers from the noise, vibration, and heat given off by this molten-metal casting hammer (*top*). Retrofit devices (*bottom*), such as those required by Occupational Safety and Health Administration regulations, can control these occupational hazards. O.S.H.A.'s regulations, based on the premise that workers have the right to a safe workplace, favor process changes such as this over "end of the pipe" solutions, according to speakers at the Washington conference held by the Society for Occupational and Environmental Health. (Photos: U.S. Dept. of Labor)

Union, a worker who becomes disabled is temporarily transferred without losing pay or seniority, notes Andrea Hricko, Health Coordinator of the Labor Occupational Health Program at Berkeley. In the U.S., however, the permanent workers in a section that has been assigned a temporarily disabled worker could charge unequal pay for equal work, claims Portia Hamlar, an attorney for Chrysler. The resolution of these conflicts may become the responsibility of the courts.

Productivity and profit naturally encourage the employment of workers who can stand a job's most extreme physical or psychological stresses. This attitude promotes a "labor Darwinism," or "survival of the superworker," says Sylvia Krekel of the Oil, Chemical, and Atomic Workers International Union. To guarantee free occupational choice, standards must safely accommodate all workers regardless of sex, age, or reproductive capacity, she says.

Your Fertility or Your Job

Recent reactions to workplace hazards and workers' special susceptibilities are seen in the case of the lead-acid battery plants. A prominent case is that of General Motors' Ontario battery plant, whose special standards are currently proposed for U.S. adoption. No woman of childbearing *capacity* is allowed to work in certain areas — an effort to prevent harm to the unborn from lead oxide emissions. The Civil Rights Act provides that U.S. women of childbearing *age* cannot be systematically excluded from jobs; a woman is presented the choice of relinquishing her fertility or her job.

Recent European studies indicate that men also suffer a decrease in fertility from lead absorption. Ms. Krekel wants serious concern paid to assuring "the reproductive capacity of both male and female." Why not make the workplace safer to all people, instead of barring the group whose risk is most obvious? she asks.

One lead industry spokesperson admits a dilemma, which management prefers to resolve by risking a sex discrimination suit rather than risking responsibility for a deformed infant. In the long run, safer battery plants are technically feasible — and will be built when time and money permit. But the immediate policy, as rhetoric predicts, is that women are last hired and first fired, since women aged 15 to 50 are assumed pregnant unless proven otherwise.

Unions don't buy industry's laments over the expense of cleanup. Large renovations are expensive, but the costs are more than offset by savings from hospital and disability compensation, says Detroit internist Dr. Janette Sherman.

Dr. Sherman observes that among her patients, women contract the same occupational diseases as men in the same jobs. But hypocrisy pervades the so-called "special protection" granted women. For example, women inspectors with the Oc-

cupational Safety and Health Administration (O.S.H.A.) are quick to note that no specifications for safety shoes smaller than men's size six (equivalent to women's size eight) have been issued, so the small-footed employee works without adequate protection. Similarly, points out Claudia Preive, industrial hygienist with United Steelworkers, respirators are not available in sizes to protect the small-faced worker near a coke oven or in a heavily leaded atmosphere. Even the available models cry for new technology to reduce exposure to more acceptable levels.

Risks in Perspective

Through the maze of questions, occupational health pioneer Dr. Harriet Hardy — she was Director of Occupational Medicine at M.I.T. from 1949 to 1971 — calls for "perspective" in lowering risk. Priorities should guide our efforts toward abolishing the most significant dangers, she said. Conference participants, in fact, criticized the time spent debating workplace risks foisted on the next generation. They were more concerned about the psychological and physical problems faced by the present generation of workers.

With its limited staff and funds, O.S.H.A. inspectors felt their present efforts might be best directed toward more inspections. They would shelve the more elusive standard-setting until workers stop falling on sloppily kept, oil-slicked floors. More inspections would encourage more enthusiastic adherence to standards, they say. Peter Robertson, Director of the Federal Liason Office of the Equal Opportunity Commission, hopes future standards will be set not according to the average healthy white male, but rather according to an up-to-date cross-section of the entire labor force. — *Melissa Weiksnar*

A Worker May Be Somebody's Mother

The noisy background of environmental pollution complicates any attempt to link individual substances to maladies. Despite this obstacle, standards must be set: every day workers are occupationally exposed to substances which are known to affect unborn life by causing birth defects, inducing cancers, or by altering genetic material. To set standards, the wide range of exposure susceptibility among fertile and non-fertile workers must be determined. The problems and prospects of this task were also debated (*see above*) at the Society for Occupational and Environmental Health's conference on Women and the Workplace in Washington this summer.

Until as late as the 1930s, medical doctors subscribed to the belief that malformed babies resulted only from hereditary and congenital causes. The human uterus was presumed then to be an inviolate protector of the unborn. Now we know better; but problems remain.

One obstacle is the difficulty researchers have in making a one-to-one correspondence between animal experiments and potential damage to humans. It's easy to prove in a laboratory that a deficiency in certain enzymes, vitamins, or minerals can cause definite malformation in the offspring of experimental animals. Yet children whose mothers have similar dietary deficiences do not suffer similar defects.

On the other hand, thalidomide's effects on the human fetus would never have been predicted had animal experiments been the only indicator. In fact, postulated Dr. Marvin Legator, Professor of Preventive Medicine and Community Health at the University of Texas, researchers were able to pinpoint cause and effect only because thalidomide's effects are distinctive. If thalidomide had produced mental retardation instead of physical deformity, its contribution would have been indistinguishable from background levels, and thalidomide might have therefore become a "safe drug." Dr. Legator takes this example as a warning that long-term usage cannot always be equated with safety.

Cancer-causing agents which have passed through the mother to the child may not appear until the child matures. Doctors at the Massachusetts General Hospital have linked the in-utero exposure to diethylstilbestrol (DES) to a rare vaginal cancer in the female offspring. Moreover, a University of Chicago study on over 800 DES-aided pregnancies showed that male offspring also experience latent effects which appear after puberty — structural damage to the genitals and abnormalities in the sperm have been observed in a significant number of cases. Larry S. Edmonds of the Center for Disease Control, thinks it possible that either parent could contribute a transplacental carcinogen.

Genetic changes brought on by workplace exposure may remain suppressed for generations. Some argue that potential fathers need special workplace protection: since a man's reproductive cells are more exposed to the environment and are constantly being generated and undergoing division, sperm production is more likely to be affected by environmental mutagens.

Dr. Legator notes that the largest source of mutagenic — gene changing — studies are microbe experiments, which unfortunately are least translatable to human systems. Studies on higher animals are needed to indicate the potential for damage in humans. To this end, he advocates the following approach to mutagens: unless researchers can show why a compound cannot be mutagenic in man, consider it a mutagen. Then, while waiting for conclusive answers, carefully monitor the people exposed and, more importantly, warn them about potential hazards.

This conservative approach of guilty until proven innocent seems antithetical to progress and is cumbersome in practice. Despite thorough testing in other areas of product safety, only a small portion of the most common prescription drugs are inspected for mutagenic potential, claimed Dr. Legator. And, the majority of herbicides, insecticides, and fungicides — where a small number of products enjoy the widest use — are not tested for genetic abnormalities, he said. Although testing methods have gained considerable credibility over the years, researchers again face the problem of translating non-human indicators to human risk.

Perhaps, hopes occupational health pioneer Dr. Harriett Hardy, researchers will soon be able to use human cell cultures to investigate hazards. For despite great advances over this last century in laboratory techniques, too much knowledge about occupational health effects still comes from after-the-fact epidemiology. — *M.W.*

TECHNOLOGY MEETS NATURE

Urban Pollution Off the Hook

The air over the North Atlantic and South Pole shows more than its share of such volatile metallic materials as zinc, antimony, selenium, and bromine. The same four materials are found with similar enrichments in urban atmospheres, the result of combustion and industrial processes. Can the zinc and selenium from urban pollution be transported to areas so remote from man's productive enterprises?

A minor mystery; and to help resolve it, Eugene J. Mroz and William H. Zoller of the University of Maryland have collected and analyzed the particulates emerging from volcanoes on Iceland and Hawaii — hot gases from lava outpourings, smoke and sulfurous fumes from active cones. Compared to the normal distribution of materials in the earth's crust, these volcanic emissions turn out, also, to be enriched in these metals.

So urban pollution may be absolved of responsibility for world wide distribution of zinc, antimony, selenium, and bromine.

Though "the chemical composition and magnitude of all natural and man-made aerosol sources is not yet well enough characterized" to assign clear-cut responsibilities, write Drs. Mroz and Zoller in *Science* (October 31, 1975), they suspect that "volcanoes may be a significant global source of these enriched elements." — *J.M.*

Loch Ness '76: Sonar and Surprises

After Robert H. Rines and his fellow monster-hunters obtained the controversial 1975 photographs of what many experts said is a large, underwater creature in Loch Ness, Scotland, they vowed to return in 1976 for an even bigger, better expedition (*see* Technology Review, *March/April, 1976*).

So in June the Academy of Applied Science, of which Dr. Rines is head, and the *New York Times* mounted the most technologically sophisticated expedition ever to hunt the legendary beast.

Their strategy was to rely upon the beast's supposed affinity for one of the camera-strobe light units. The creature had apparently been attracted by a 16-mm elapsed-time underwater camera which had obtained pictures successfully for past expeditions — in 1972 a shot of a large flipper, and in 1975 the two pictures said to be the animal's head, and neck and upper torso. For reasons unknown to the team, the animal appeared to bump and bash this camera in 1975, hitting it so hard that the camera was swung up to aim at the surface, rather than horizontally into the loch.

So the 1976 expedition featured a ten-foot-long steel frame, loaded with cameras, all of which were aimed at the 16-mm "bait" camera on another frame. On the large frame were two side-by-side 35-mm cameras which would produce stereoscopic pictures to be used for estimating the size of the creature. Also hung on the frame were a specially modified Polaroid SX-70 underwater camera to give instant pictures of the beast and a television camera to allow a shore-based operator to monitor the cameras and trigger them if something interesting should enter the field of view. A videotape recorder attached to the shore-based television monitor would give moving pictures of whatever might swim into range.

The racks of electronics were suspended about 30 feet below the loch surface, in about 70 feet of water. The apparatus was moored in Urquhart Bay, at the same spot where past pictures were obtained. Shepherding the equipment were M.I.T. Professor Harold E. "Doc" Edgerton, renowned inventor of the strobe light and builder of underwater cameras; Charles W. Wyckoff, inventor of films used to photograph atomic blasts and the surface of the moon; and Dr. Rines, a patent lawyer-engineer credited with inventions in sonar and radar. Other hands also lent their expertise to the camera work, including John Lothrop, chief experimental camera engineer for Polaroid Corp., and Sam Raymond, President of Benthos, Inc., manufacturers of underwater cameras.

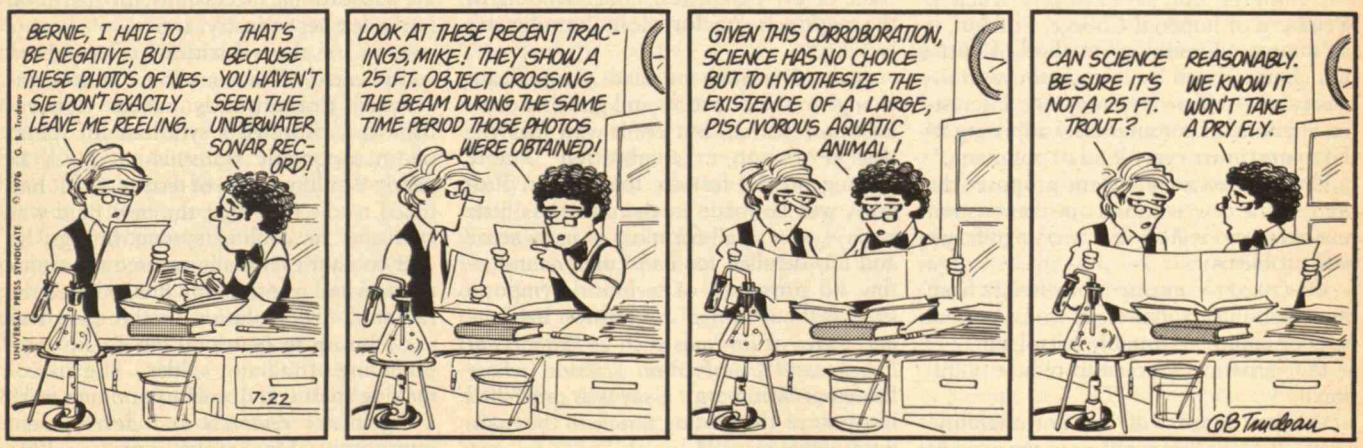
The 1976 expedition also included a sophisticated sonar survey of several shallow areas of Loch Ness, in a hunt for skeletal remains of the animals on the bottom. The sonar experts were Martin Klein, president of Klein Associates, a New Hampshire sonar firm, and an engineer with the firm, Charles Finkelstein. Their side-scan sonar system used a four-foot-long, torpedo-shaped "fish" which blanketed the bottom to the right and left with sound pulses when towed behind a boat. A recorder on board played out a paper chart with a sonar picture of the reflections, which revealed what lay on the bottom. In addition, the Klein sonar system had a new wrinkle. Accompanying the two sonar beams sprayed out from either side of the towed fish was a third, aimed straight downward, that could penetrate bottom sediments to reveal structures beneath the bottom.

The sonar search was predicated on the assumptions that the Loch Ness creatures possess bones and that any dead animals would sink to the bottom of the loch and stay there. The zoologist on the search, Christopher McGowan of the Royal Ontario Museum is convinced that the loch's reputation for "never giving up the dead" is well-founded. Dead animals or human drowning victims do not decay quickly because the cold waters of the loch prevent bacteria from proliferating rapidly in the bodies. Thus, very little internal gas is created to buoy the bodies, and they sink, to be devoured by eels and other scavengers.

The results of the summer-long expedition were mixed. The underwater cameras, operating through June and July, photographed only an occasional salmon. The investigators theorized that the beast was not in evidence because there was, inexplicably, little of the usual migration of trout or spawning salmon into the loch from the North Sea. The scientists believe that the colony of beasts in the loch feed on the salmon, and the migration draws the animals into the shallows, where the salmon congregate.

However, there was a plethora of results from a fixed sonar beam, run by Doc Edgerton, aimed into the loch to monitor the area around the banks of underwater cameras. Heavy black tracings on the sonar charts told the story of solid targets, several meters thick, moving into the sonar beam and out again. But the objects stayed out toward the middle of Urquhart Bay, never approaching the underwater cameras moored about 300 feet offshore.

The sonar survey of the loch bottom by Klein and Finkelstein also produced exciting results. The search uncovered many large rings of stone, ranging from 15 feet to 100 feet in diameter, in the shallow area of the loch known as Lochend. These rings were presumably built by ancient settlers as burial vaults or religious centers thousands of years ago, when the water level of the loch was much lower. The rising waters covered the rings, perhaps protecting them from the vandalism and destruction which have plagued many of the 900 or so other stone rings throughout the British Isles. Thus, the find could have



major archaeological significance, enabling better knowledge of the meaning behind the mysterious stone rings.

The sonar survey also revealed several large objects on the bottom, many meters long, which Klein says have at least a small chance of being carcasses of large animals. One such sonar trace they jokingly call "the average plesiosaur," because it has a shape vaguely similar to the long-necked, flippered prehistoric reptile which has been a candidate for the Loch Ness monster.

But the 1976 expedition, and the long-term search for the monster for that matter, is by no means over. The 16-mm elapsed-time camera was left in the loch in July, rigged to a sonar device which aims a sound beam out into the loch. When a computer in the system monitoring the beam determines that a large object has intruded into the beam, it activates the camera-strobe light system, which will begin taking pictures every four or five seconds. Local personnel have been trained to maintain the camera until Dr. Rines and other team members return to the loch this month for more camera work, and for diving. Then, the investigators hope, the salmon will have begun migrating into the loch, and the underwater animals will be lured from the depths of the loch into the shallows where the expedition cameras will await them. The 1976 expedition will be reported on fully in the December issue of *Technology Review*. — *D.M.*

The Quiet Changes in Combustion

The flame so assiduously fired and fed in countless furnaces and boilers today is essentially the same as the one our human ancestors captured from volcanoes and thunderstorms. For all our technology and all our inventions, we rely wholly on the "mixing controlled-diffusion" flame, whose basic characteristic is that its structure remains unaffected by the rate of the reaction.

It is the only combustion reaction nature employs. But, says Professor Felix J. Weinberg of Imperial College, London, it is "a most undesirable" method of burning, characterized by low combustion intensity, low efficiency, and "the interesting attribute of automatically adjusting itself to maximize every kind of pollutant."

Thus Professor Weinberg proposes the need for a new emphasis in combustion research, motivated by two significant new problems:

— Our need to squeeze more energy from our dwindling supplies of conventional fuels of choice — notably petroleum.

— Our growing concern to reduce pollution.

The key word will be controllability: controlling the temperature in the zone of the combustion reaction, controlling the reaction rate independently of the ratio of air and fuel, controlling the rate of the reactions which produce pollutants separately from those which produce heat. A substantial agenda, Professor Weinberg said, especially remarkable because it represents problems unresolved and hardly even appreciated in more than half a million years of human experience using fire.

Opening the 16th International Combustion Symposium at M.I.T. this summer, John P. Longwell of Exxon's Corporate Research Laboratories (he is also Visiting Professor of Chemical Engineering at M.I.T.) chose to focus on one aspect of Professor Weinberg's agenda: how to find a substitute for depleting petroleum-based fuels for transportation. Professor Longwell outlined two possibilities: either the transportation sector can find and adopt combustion systems that will efficiently use a fuel whose ratio of hydrogen to carbon (H/C) is low, and which can be readily made from coal, in place of high-H/C-ratio petroleum-based fuel; or the energy industry can find economical ways of making high-H/C-ratio synthetic fuels from coal. Whichever way it goes, Professor Longwell is convinced that in time, coal liquefaction will be the major source of liquid fuels, particularly for the transportation sector.

There is no obvious route to either goal. To create 40 gallons of high-H/C-ratio fuel from coal requires the addition of 10,000 cubic feet of hydrogen, and this implies expending a lot of energy, perhaps one-quarter of the amount in the final product. (By comparison, refining one gallon of gasoline may consume in energy 10 per cent of the amount being made ready for the consumer.) On this basis alone, Professor Longwell predicts that coal-derived high-H/C-ratio liquids will cost at least twice as much as imported crude costs today.

To substitute gas turbines and Stirling-cycle engines for the internal combustion engine, thus sidestepping the need for high-H/C-ratio fuel, may be a better alternative. Professor Longwell admits, however, that neither of these systems is "presently developed for such fuels, and basic or even empirical understanding of the requirements for clean burning are lacking."

Such ideas may portend a significant change in the direction and goals of combustion research. But don't wait for "the new revolution in combustion" before turning on the furnace this winter. Progress will be made in the countless little steps — too small for most of us to sense and too detailed for us to understand — that fill programs of technical symposia such as those of the Combustion Institute and pages of journals such as *Progress in Energy and Combustion Science* (where Professor Weinberg's essay was published last year as the leading article in the inaugural issue). — *J.M.*

Firing Snowslides

The standard method of preventing uncontrolled snowslides is to trigger controlled avalanches by artillery fire. But time is running out: obsolete artillery and ammunition for it are harder and harder to find, and their use is increasingly encumbered by environmental red tape.

Two alternatives have now been proved in Colorado and are being tested by University of Washington engineers on the heavier snow accumulations typical of the Cascades:

— Place inflatable air bags at critical points before heavy snowfalls. Sudden inflation — which can be triggered remotely — initiates the desired avalanche when snow structures collapse.

— Substitute heavy steel cannisters charged with acetylene and oxygen for conventional explosives. These can be triggered, recharged, and reignited remotely, becoming in effect permanent installations which need be visited only a few times a year. — *J.M.*

Can Whale Oil Be Made Obsolete?

If you would "stop the whale-killers," what of your watch, your automobile, your cosmetics, and even your shoes?

No one knows all the specific end uses of sperm oil, the most valuable of the several grades of oil obtained from whales (many uses are proprietary). But it is no accident that the U.S. now imports some 55 million pounds of sperm oil a year (perhaps 20 per cent of world production), and finding substitutes remains a major challenge for chemical research, writes Arnold Frankel, Chairman of the Board of Aceto Chemical Co., in *Chemtech* (*May, 1976*).

Some sperm-oil substitutes have been successful — for example, watch lubricants, which used to be 80 per cent sperm oil and 20 per cent synthetic oils. Now the proportions are reversed, writes Mr. Frankel, and the new lubricants perform better than their predecessors. Synthetics are substituting successfully for sperm oil in the leather industry, too.

Some of the substitutions have been complicated. Transmission failures increased dramatically when General Motors substituted a synthetic for sperm oil in automatic transmission fluid. In nearly 9 million miles of testing, G.M. had failed to discover that the new fluid was corrosive to cooling system fittings, so that coolant eventually entered the transmission and transmission fluid entered the radiator. (The solution in this case was not a return to sperm oil but a new compounding of radiator solder.) The task of making sperm oil obsolete continues to be a significant research and development opportunity, Mr. Frankel writes. — *J.M.*

External Pressure on Internal Assessment

In the best-laid plans department: a technology assessment of the late 1960s cannot consider issues unrecognized until the 1970s. In the case of Monsanto, even the company's sophisticated and expensive internal assessment of plastic beverage bottles, planned almost ten years ago, has not preserved the product from criticism.

Coca Cola is now sold in plastic, 32-oz. bottles throughout Rhode Island and Connecticut. The bottles, representing a new approach to packaging beverages, have cost the Monsanto Co. tens of millions of dollars and 15 years to produce. However, the Natural Resources Defense Council, citing the possibility that soda drinkers might ingest the acrylonitrile-styrene monomers if they leach from the bottles to the beverage, is suing to prohibit the sale and use of the bottles until further testing is completed.

The environmentalists' attack was not completely unexpected. "What we've produced is a made-to-order symbol of plastic, throwaway society," says Fred D. Wharton, Monsanto's Manager of Environmental Affairs. In fact, by 1967 Monsanto researchers had predicted the environmental and consumers' movements, as well as the energy shortage, and planned their assault on the beverage market accordingly, he says.

In 1973, Monsanto held a symposium on its "Cycle-Safe" bottle, reviewing research which Mr. Wharton calls "a model experiment in technology assessment." Hoping to stave off possible objections, the symposium scored the following points:

— The energy required to produce the bottle is comparable to that used in the manufacture of glass and steel containers, and less than that of aluminum. If the plastic bottles were recycled — that is, recovered, ground into plastic powder, and re-formed into bottles — they would be more frugal energy consumers than their nonrecycled competitors.

— When incinerated under "proper conditions," involving high temperatures and plenty of oxygen, the bottle is "almost completely consumed." Under improper conditions, an increase in smoke is noted. Experimental refuse fires, fueled by 15 per cent acrylonitrile-styrene, showed no appreciable increase in harmful gases, the report said.

— The bottle is light, resists breakage, and floats. Because it does not decompose naturally, Monsanto claims the bottle will lend "stability" to solid waste heaps.

— The petroleum energy used to produce the plastic in the bottles is to some extent recoverable, provided the bottles are burned and their heat recovered.

Monsanto took painstaking measures to protect the bottle from criticism. For example, hamburger was cooked over the flames of burning bottles and fed to rats. This test was designed to alleviate worries that an occasional bottle thrown into a cookfire might harm the weenies roasting above it. The "bottle-fed" rats grew more slowly than usual, but seemed to suffer no extensive ill effects.

Now the N.R.D.C. has discovered a possible chink in the armor of research: its attorneys filed suit in April asking the Food and Drug Administration to withdraw interim approval of acrylonitrile-styrene bottles. "Serious unresolved questions" about chemicals migrating from the plastic container into the soda pop and thus into the bodies of consumers motivated the suit, said the N.R.D.C. The Council doubts the safety of the 0.3 parts per million of the acrylonitrile monomer which strayed from an experimental piece of plastic into the beverage after 65 days of storage at 120°F. Since the experimental plastic was not the same as the plastic which makes up the bottle, and because opinions vary on how long soda pop sits

on store shelves before it is consumed, or at what temperatures beverages are shipped, such concern may or may not be warranted. Marcia Cleveland, attorney for the N.R.D.C., says the Council hopes the F.D.A. will ban the bottle until data on migration of the chemicals have been gathered. This review could conceivably delay the proliferation of the plastic bottles by another year or more, she said.

Mr. Wharton anticipated the N.R.D.C.'s charge in 1973. At that time it was pointed out that in-depth tests on the possible health effects of chemical migration — ranging from tests for birth defects to tests for cancer — had not been conducted. But all the bottle's components are already regulated by the F.D.A., said Mr. Wharton, so the bottle represents "no new composition of matter."

There are a couple of other bugs in the bottle, both of which Monsanto quietly admits and the N.R.D.C. eagerly cites. Both have to do with slowing the bottle's progress from home refrigerator to garbage dump. Monsanto engineers have not yet found a way to make the bottles refillable, and no one has yet found a way to make people return their empties for recycling.

Although a refillable bottle was promised in "a couple of years" in 1973, Mr. Wharton reports that the refillable bottle is still some months away. The problem is "creep," the slight stretching the bottle experiences under the high pressures of automatic bottling. Bottlers who usually fill to standard level, rather than by volume, won't accept a bottle which grows about five per cent with each refilling. So the bottles, despite their long-lived properties, must either be discarded or recycled. (One-trip bottles will continue to be marketed even after returnable bottles are perfected, one Monsanto spokesperson assures.)

Collecting the bottles to be recycled presents more difficulties. First, as the N.R.D.C. points out, Monsanto's bottles must be recycled separately from other plastic bottles to prevent the inadvertent mixture of toxic plastics with the acrylonitrile-styrene. Sorting aside, Monsanto would be happy to get the bottles back at all.

"We anticipate making a profit on recycling. We're paying 1.8 cents per 32-oz. bottle for re-collection," says Mr. Wharton. But this incentive hasn't encouraged enough consumers in the two test markets to carry their empties back to the store. Pilot recycling centers in shopping areas haven't drawn much response either, Mr. Wharton reports. Most successful was a company-sponsored plan to award prizes to grade schools on the basis of the bottles collected by their pupils. But unless such programs are established across the country, Monsanto's "Cycle-Safe" product will probably remain largely unrecycled.

Despite the roadblocks on the way to market, the bottle's economic prospects are still enticing. A decade ago, company researchers predicted a "multibillion-dollar market" in the beverage container field. Events confirm the prediction: 37 billion nonreturnable containers were sold in 1975 alone. If Monsanto can capture even a tenth of that market, the time and expense of its internal technology assessment will be justified — *S.J.N.*

$ENR = 25.22 - .36(ENR - 5) + .68(RD) + .32(FRB) + .18(FRB - 1) - 2.67(ALT) + .36(ENR - 1) + \mu$

How many students will want to study engineering in 1980? Since 1970 engineering school enrollments have dropped more than 30 per cent and then rebounded nearly 20 per cent. How shall college deans — to say nothing of U.S. corporate personnel managers — respond to such "incredible fluctuations" in U.S. collegians' response to engineering as a professional opportunity?

The formula above is proposed by three members of M.I.T.'s Center for Policy Alternatives as a predictor of future engineering enrollments. The basic concept is that of Professor Richard B. Freeman of Harvard: there is nothing capricious about American college students; they respond to demand — and potential salaries, as they see them — in a very pragmatic way.

In essence, the formula states that the number of first-year engineering enrollments (ENR) increases as engineers' starting salaries increase in response to growing demand and decreases when salaries decline due to surpluses of graduates — the number of graduates being directly related to the first-year enrollments five years earlier (ENR − 5). Demand, in turn, is a function of the current level of research and development expenditures (RD), the production of durable goods in the current (FRB) and preceding (FRB − 1) year. First-year engineering enrollments vary inversely with the level of salaries available to non-college graduates (ALT). The response to changes in these factors is not immediate, so one year's enrollment is in part a function of the previous year's (ENR − 1).

The coefficients in the formula are derived from engineering enrollment trends between 1951 and 1974. Despite the downturn in the economy in 1975, the equation accurately forecast in enrollment last fall, as — for the first time in 25 years — salaries in alternative occupations (ALT) declined (in real terms) in 1974. The immediate effect was to drive engineering enrollments up rapidly.

Assuming that collegians haven't changed their basic behavior since 1972, Baruch Raz, Marvin Sirbu, Jr., and Robert Treitel used national economic variables to calculate future engineering enrollments. Their assumptions:

— Research and development expenditures will increase 1.5 per cent in real terms to 1980 and 2.5 per cent (real terms) to 1985.

— Durable goods production will see a real annual growth of 4 per cent to 1985.

— Alternative salaries will grow 1.8 per cent per year to 1985.

The chart shows the results. The upturn in enrollments which began in 1973 will continue until 1979, then fall off through at least 1985. In other words, the oscillatory behavior of engineering enrollments from 1950 to 1975 will continue. Such behavior is inherent in the system, because of "the lag between enrollment and graduation." As if to fulfill this prophecy, John D. Alden, Director of Engineering Manpower Commission, cites recent growth of engineering enrollments and notes "concern in some circles that further increases in enrollments may lead to excessive numbers of graduates in future years." — *J.M.*

First-year enrollments in U.S. engineering colleges have varied cyclically since 1950, and they will continue to do so in the future according to an analysis by three members of M.I.T.'s Center for Policy Alternatives. The level of enrollment is determined by the supply and demand for engineers as perceived by prospective students, and the cyclical character is the result of the lag between enrollment and graduation.

Fuel Economy in Aircraft Design

Even as the most extravagant commercial aircraft yet built were entering commercial supersonic service for Russia, England, and France, U.S. aeronautical engineers were scanning a wholly different agenda. A task force drawn from N.A.S.A., the Department of Transportation, the Federal Aviation Administration, and the Department of Defense last winter defined six programs — the research may cost nearly $700 million — which could lead to reducing by nearly half the fuel required per unit of passenger travel on commercial airliners.

The six proposed routes to greater fuel economy are:

— Use new technology to redesign certain components of existing jet engines to make these engines more fuel-efficient. The goal is a 5 per cent improvement over current engines.

— Begin research and development on a wholly new jet engine designed specifically to save fuel as current jet engines were to achieve high power and low weight. Savings of 10 to 15 per cent are proposed.

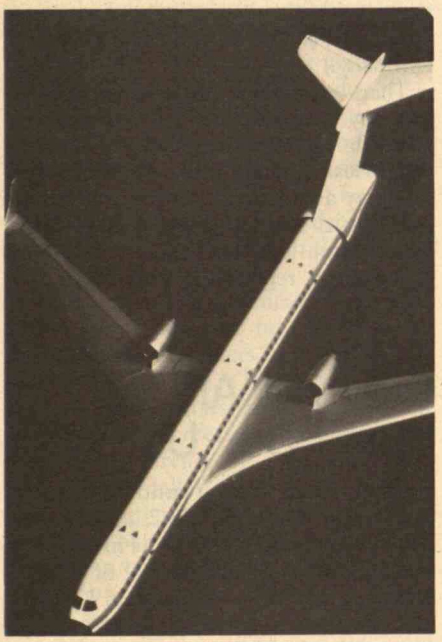
— Reverse history by moving back to turboprop engines. Propeller-driven aircraft are inherently more fuel-efficient than jets, and new technology suggests that turboprop engines can now be built to operate at the high speeds and altitudes of jet-powered craft with fuel savings of 15 to 20 per cent — and if speed lower than Mach 0.8 were acceptable, "even greater" savings are likely.

— Use new aerodynamics to design a new "fuel-conservative" transport. Some may be suitable for retrofit, but a wholly new generation of transports will be required to achieve fuel savings of 10 to 20 per cent.

— If the new "fuel-conservative" transport can incorporate devices to smooth the flow of air past its skin — suction through slots or porous surfaces to maintain "laminar" flow — the savings may be still more spectacular — 20 to 40 per cent.

— Substitute new composite materials for metals in the structure of future aircraft to save 25 per cent in weight and 10 to 15 per cent in fuel.

Raymond L. Bisplinghoff, Chancellor of the University of Missouri at Rolla, reported enthusiastically for a N.A.S.A. Advisory Board of which he was chairman. No wonder: a 1 per cent fuel savings, said the Board, "translates to approximately $50 million per year in today's market for U.S. domestic operators." But even that level of savings may not be incentive enough for an innovative engineering effort, fears Dr. Bisplinghoff. For example, the technology is now in hand for a new "high-by-pass" jet engine to replace existing engines in narrow-body jets (B-707, DC-8, B-727, and DC-9, for example); it would reduce fuel consumption by just short of 5 per cent. But the new engines are not being ordered; "the airlines find it cheaper to buy more fuel than to invest in expensive new equipment," Dr. Bisplinthoff told the Senate Committee on Aeronautical and Space Sciences late last year. A logical decision from the operators' point of view, he says, but not from the nation's. Dr. Bisplinghoff argues that "a national investment in improved equipment made in the U.S. is a better investment than the continued importation of Middle Eastern oil," and he wants "a better climate for capital formation" so that aeronautical technology can achieve its potential. — *J.M.*



A "fuel-conservative" transport would have longer, narrow wings with vertical "winglets" to produce forward thrust in the airflow (5 per cent improvement in aerodynamic efficiency), smaller engines in lightweight nacelles, and smaller "tail" surfaces. (Photo: Bruce H. Frisch)

Cutting the Cost of Free Energy

Sunlight is free, but the cost of retrieving and using it has always been prohibitively high. So the list of solar priorities has been headed not by efficiency, but by cost effectiveness. When a solar collector achieves both, researchers will know they have a winner.

Ironically, the efficient collection of "free" sunlight is the most expensive part of solar energy conversion. Solar cells which absorb sunlight and transform it into electrical power cost about $1.50 per kilowatt-hour of electricity produced, making them about 50 times more expensive than conventional electrical generation methods. A reflecting concentrator can focus the sunlight from a large area onto a smaller number of solar cells. But these cup-shaped concentrators, unlike flat pans of cells, must track the sun to maintain their focus on the cells. Such precision tracking often requires expensive mechanical and structural components.

A 4-by-12-foot working model of the solar photovoltaic conversion system developed at M.I.T. is now being tested atop M.I.T.'s Building 24.

An M.I.T. solar research team believes it has made cost-cutting progress using an innovative concentrator and inexpensive tracking mechanisms. Materials scientists Roy Kaplow and Robert Frank unveiled their model solar collector this June.

The experimental solar collector uses a large concave mirror to focus sunlight onto a small convex mirror, and, in turn, onto a few photovoltaic cells mounted behind a small hole in the primary mirror. Each solar cell basks in 500 to 1,000 times the amount of sunlight it could collect by itself. "It's cheaper to produce mirrors than silicon cells," Dr. Kaplow explains.

The team members have turned a possible snag in the use of such highly concentrated sunlight to their advantage. To prevent the intensely bright beam from melting the small cells that absorb it, water is channeled through conductive blocks supporting the cells. While cooling the cells, the water reaches temperatures of 150° to 200°F., and can be used for hot water and space heating.

Each mirror is individually supported by a "double gimbal" arrangement, similar to the supporting system which maintains the horizontal alignment of a ship's compass. The gimbals rotate the mirrors on two perpendicular axes to allow for the daily and yearly motions of the earth.

A time-based diurnal drive keeps the gimbals "tracking" the sun, and a feed-

	Energy consumption (thousands of B.t.u.s.) per dollar value of shipments		West Germany as per cent of United States
	United States	West Germany	
Food	11.9	8.3	70
Paper	104.0	38.6	37
Chemicals	71.8	40.8	57
Petroleum and coal products	112.0	56.0	50
Stone, clay, glass, and concrete products	75.3	54.8	73
Primary metals	97.0	77.6	80
Total for six energy-intensive industries	61.2	42.4	69
Other manufacturing	9.4	7.1	76
Industry total	34.8	25.1	72

U.S. industry uses 40 per cent more energy in relation to its industrial output than West German industry, according to data assembled by Ronald K. White and Richard L. Goen of Stanford Research Institute for the F.E.A. Similar contrasts between Swedish and U.S. industry have been developed by Lee Schipper and A. J. Lichtenberg of the University of California (Berkeley) Energy and Resources Group.

back system monitors the amount of sunlight received by the solar cells. The electrical output of the solar cells decreases when the mirrors are not accurately focused, and the feedback system alters the gimbals' position with the help of small electric motors to follow the sun through the day.

As a supplement to utility-supplied electricity, this system could reduce a homeowner's electric bills, lessen electrical transmission losses, and promote local energy generation. Dr. Kaplow says that hospitals and industrial plants, which would consume all the energy and hot water as it is produced thus bypassing the need for storage, are prime targets for initial installment.

While the solar collector is not yet ready for the marketplace, patent applications have been filed on various aspects of the system. The research is sponsored by the National Patent Development Corp., an international firm that carries out research and development of high technology products for industry. — *S.J.N.*

Energy Efficiency, European Style

Low energy consumption does not necessarily mean low standard of living. Two new studies reporting on patterns of energy consumption in West Germany and Sweden suggest that energy conservation goals as high as 20 or 30 per cent need not imply fundamental changes in our life style — indeed, may not imply restrictions and discomforts at all.

The per-capita gross national product (G.N.P.) of Sweden, West Germany, and the U.S. are comparable. So are the standards of living, demographics, and economic activities. But energy consumption in Sweden and West Germany is 10 megawatts per $1,000 of G.N.P., compared to 18 megawatts in the U.S.

Some of this difference has to be assigned to endemic advantages — concentrated populations and short distances between industrial centers, for example, in Sweden and West Germany. But much of it is the result of fundamental differences in attitudes and ways of doing things. From their study of the Swedish economy, Lee Schipper and A. J. Lichtenberg of the University of California (Berkeley) conclude that more efficient energy use in the model of Sweden would "not interfere with the function of the American economy." The West German example suggests the same thing to Ronald K. White and Richard L. Goen of Stanford Research Institute. "Continuing U.S. economic growth and improvement in the U.S. standard of living should be possible without a proportionate increase in energy consumption," says a Federal Energy Administration summary of these studies.

The differences are best revealed in sector-by-sector analyses:

Transportation: Swedes and Germans travel mostly by public transportation and mostly by rail, and their cars — when they use them — consume only 60 per cent as much fuel per passenger-mile as those in the U.S. Just over half of Swedes' trips of 10 km or less are made by automobile — compared with 90 per cent in the U.S. Mass transit accounts for 75 per cent of all commuting in Stockholm, Malmö, and Göteborg.

Residential: West Germans use only about half as much energy for space heating as Americans; their houses are smaller, and they heat only the rooms in use. Residential use of energy for other than heating in West Germany is only one-fourth of that in the U.S. — no air conditioning, fewer appliances. The same differences exist in Sweden.

Industrial: The products of Swedish and German industry are more energy-intensive than those of the U.S., but they are made with less energy. Paper, for example — a major Swedish product, an industry that consumes 16 per cent of all Swedish energy — is made in mills that obtain 60 per cent of their energy from their own waste products; the average in the U.S. is 35 per cent. West German paper mills use 26.6 million B.t.u.s per ton of paper produced; U.S. mills use 46.6 million. In both Sweden and Germany "co-generation" of electricity is common: industrial process heat is used to generate electricity for the plant in which it is made and for sale to the communities surrounding; and even the heat from the generators, otherwise wasted, is commonly used for heating factories and homes nearby. Utilities produce 94 per cent of U.S. electricity, only 71.5 per cent of West German electricity.

(A recent study by Dow Chemical Co., quoted by Dr. Schipper, notes that if U.S. industrial power users "co-generated" electricity and heat, sharing power and steam with existing utilities, the savings would be 725,000 barrels of oil or equivalent daily.)

There are smaller life-style differences, too, say Drs. Schipper and Lichtenberg. Swedish automobiles, on the average, weigh less and are more economical — and they are made to last longer. Returnable bottles are widely used. Plastic bags, which came into use in the 1960s, have disappeared, replaced by paper. — *J.M.*

Why the Arabs Won't Buy Us Out

Despite their new-found and ever-increasing wealth, O.P.E.C. investors are not likely to make large-scale investments leading to managerial control of U.S. enterprises, say Professors Stephen J. Kobrin and Donald R. Lessard of the M.I.T. Sloan School of Management.

Two reasons:

— O.P.E.C. investors have every reason to want to invest in U.S. industry but no reason to want to control it. An investor seeking corporate control does so because he believes he can through his control in-

crease his profits. But O.P.E.C. investors lack the managerial and technological advantages over Americans to allow them to take full advantage of corporate control. They are better off taking minority positions and letting American managers use their considerable skills to maximize everyone's profits.

— No O.P.E.C. investor is so rich that he can expect to exercise majority control in more than a very few American firms. To do so he would sacrifice diversity in his investment portfolio — and so increase his risk. To date O.P.E.C. investors appear to have been "risk-averse" in the market, say Professors Kobrin and Lessard.

By the end of 1973, foreign direct investment in the U.S. amounted to almost $18 billion; U.S. direct investment abroad was over $107 billion. We need hardly have a "xenophobic reaction" to new foreign money, say Professors Kobrin and Lessard. Such a reaction would be counterproductive: "We cannot expect equitable and fair treatment of U.S. investors abroad while at the same time restricting investors at home because they happen not to be U.S. citizens." — *J.M.*

Thermal Pricing

Energy conservation depends on consumers receiving the right price signals in the market.

Start with what Professor Sir William Hawthorne, who teaches in Churchill College, Cambridge, and M.I.T., calls "thermal pricing" — that is, fuel prices set in proportion to both the calorific value of the fuel and the relative efficiency with which those calories are available.

Then try to anticipate what prices will be in the future by marking down — slightly — the most common fuels and marking up the scarce ones. Modify the "thermal price," too, to compensate for differences in the fuel's ease of handling and storing. Then let people decide how much of which fuel to use on the basis of such rationalized prices.

"It is perhaps not sufficiently realized that underpricing one fuel leads to its waste relative to others and hence to a general waste of fuel, a higher demand for all fuels, and a consequent pressure on world prices," Professor Hawthorne told a British conference on future resources problems last fall.

"So the provision of cheap natural gas to a group of customers is not only a way of running out of gas more quickly, but also a way of ensuring that O.P.E.C. countries can maintain or increase the price of oil. The provision of especially cheap hydroelectric power to aluminum producers is another example worthy of examination; perhaps it has already led to a waste of the world's hydroelectric resources," said Professor Hawthorne. — *J.M.*

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As the molecular workings of the brain are elucidated, the actions of drugs can be better understood. The amphetamines provide an example.

Pharmacology and the Brain

Since ancient times, drugs have been used to restore mental health or explore the mind. Indeed, it was said that the Homeric physician Polydama presented Menelaos and Helen with "a drug against sorrow and anger, a drug to survive despair" on their way home to Troy. The number of mind-bending, mood-altering, behavior-modifying drugs available today is countless. Some have altered the course of medical practice and clinical treatment; others have changed the fabric of our society. Many have greater specificity of action and fewer side effects than ever before.

The development of such drugs has been paralleled by our increased knowledge of how drugs work on the molecular level to modify behavior. In this regard, one of the most fruitful research approaches has involved the study of how nerve cells communicate with other cells in the body, and how various drugs might alter this communication.

Neurons and Neurotransmitters

A specialized cell called the neuron is the basic unit and workhorse of the nervous system. The total number of such cells is staggering: rough estimates for the brain alone range from 10^{10} neurons to several times this number.

Although neurons may differ in terms of shape, function, or size, most of these cells share a number of anatomical features, as shown in the illustration on page 28. Nearly all neurons have *dendrites* — filamentous outgrowths of the cell that receive information from other cells. The dendrites generally convey this coded information to the *cell body*. From here, a specialized extension of the cell — the *axon* — carries an electrical impulse to the cell's *terminals*. The length of the neuron is determined in large part by the length of the axon; in humans that length varies from less than a millimeter to well over 60 centimeters.

Communication between neurons appears for the most part to be a chemically mediated event, for the terminals of some neurons contain organelles called synaptic vesicles that are believed to be sites where chemicals called neurotransmitters are stored. Intercellular communication involves the release of various amounts of such chemicals from the terminals. The released molecules cross small gaps called *synapses* that are often narrower than 300 to 400 Ångstroms, and then interact with so-called *receptors* on the postsynaptic cell to produce a biological response. (An electron-micrograph of a synapse appears on the opposite page. It appears that only one kind of neurotransmitter is released from the terminals of any given neuron. Hence, each neuron of the brain or peripheral nervous system can be characterized by the type of neurotransmitter that it employs.

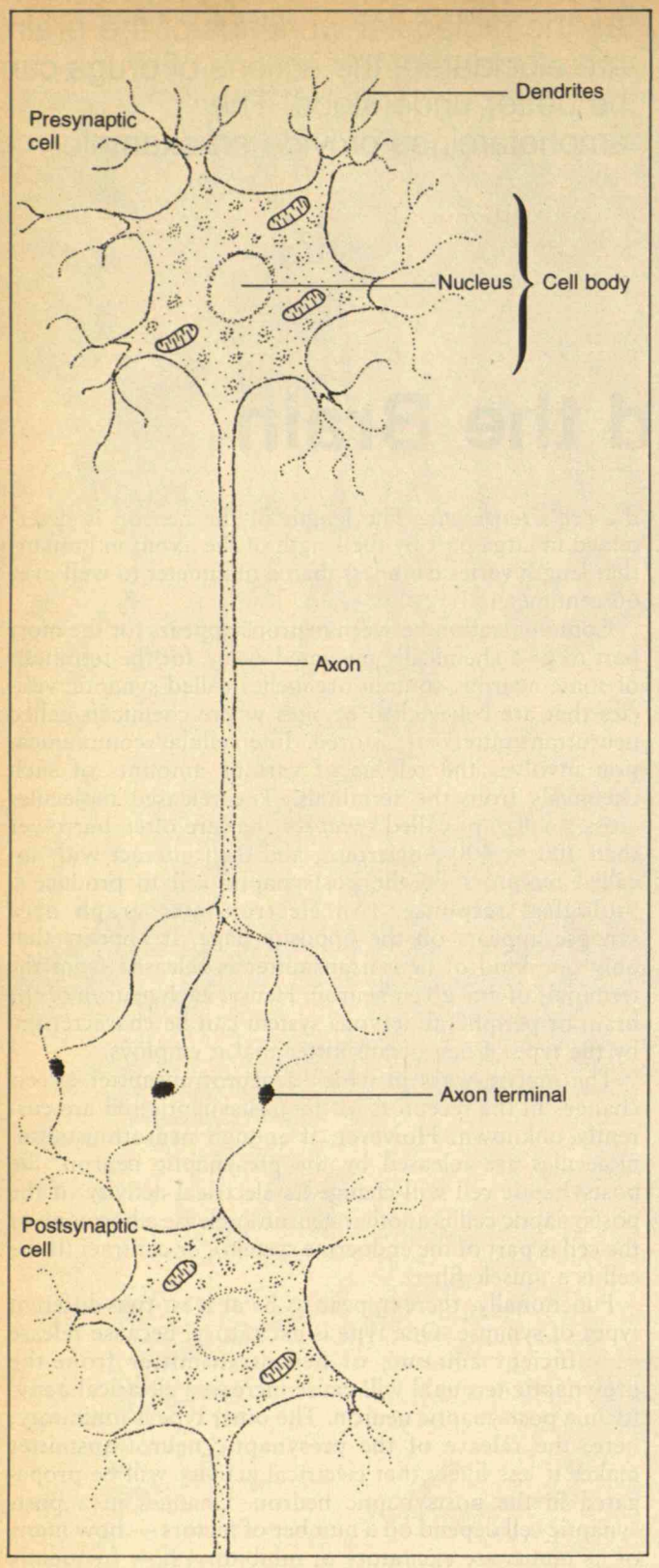
The precise ways in which a neurotransmitter effects changes in the receptors of the postsynaptic cell are currently unknown. However, if enough neurotransmitter molecules are released by the presynaptic neuron, the postsynaptic cell will change its electrical activity (if the postsynaptic cell is another neuron), release a hormone (if the cell is part of the endocrine system), or contract (if the cell is a muscle fiber).

Functionally, there appear to be at least two different types of synapse. One type is excitatory, because release of sufficient amounts of neurotransmitter from the presynaptic terminal will cause increased electrical activity in a postsynaptic neuron. The other type is inhibitory; here, the release of the presynaptic neurotransmitter makes it less likely that electrical activity will be propagated in the postsynaptic neuron. Changes in a postsynaptic cell depend on a number of factors — how many of its inputs are excitatory or inhibitory, how frequently the presynaptic neurons release sufficient amounts of neurotransmitter per unit time, how much neurotransmitter is available for release from the presynaptic neurons, and so on.

Catecholamine Neurotransmitters

A set of formal criteria has been established to determine whether a given chemical compound found in the nervous system might qualify as a neurotransmitter. First, a population of neurons should be found to have the necessary metabolic machinery (or enzymes) to synthesize the

The synapse — a site where communication between nerve cells is believed to occur. Extending diagonally downward from the upper right of the photograph is a nerve-cell outgrowth called an axon. At its end (near the center of the photograph) there is a clustering of spherical structures. These are the so-called synaptic vesicles. Just beneath them, the nerve cell's membrane is thicker than elsewhere; and the adjacent membrane of a second nerve is thickened as well. The synaptic vesicles, under certain circumstances, are believed to release their chemical contents into the gap between the two thickened membranes; the name synapse refers to this gap. The photograph was taken under the electron microscope at a magnification of 48,000 diameters by Dr. Stephen G. Waxman, now at M.I.T.; it shows a minute portion of the brain of a cat.



The communication chain from nerve cell to nerve cell is shown in schematic diagram. In general, each nerve cell has filamentous outgrowths called dendrites that receive information from other cells. This information is conveyed to the cell body in the form of an electrical disturbance on the cell membrane. The arriving information is integrated; and the cell, if its excitation is sufficiently great, will generate activity of its own — an electrical spike called an action potential, which travels down the cell's so-called axon. At the axon's terminals (shown photographically at the beginning of this article) the electrical activity is transformed into the release of a neurotransmitter — a chemical that induces electrical activity in the next cell in the chain.

chemical, or should have a mechanism to take up the chemical from the fluid surrounding the cell. Second, electrical stimulation of these neurons should cause a release of the chemical into synapses, and the chemical should then interact with receptors on postsynaptic cells to produce a biological response. Finally, mechanisms should be available to terminate rapidly the actions of the released chemical; otherwise, its effects would persist, and precise control over communication between cells would be lost.

The present level of technical expertise is not sufficient to demonstrate unequivocally that all chemicals thought to be neurotransmitters in the brain are neurotransmitters in fact; however, some compounds studied in the peripheral nervous system do satisfy the formal criteria. Even in the brain, enough indirect evidence has accumulated to suggest that a number of compounds qualify as the messengers by which neurons communicate with other cells. Among these putative (hypothesized) neurotransmitters, the compounds dopamine, norepinephrine, acetylcholine, serotonin, and gamma-aminobutyric acid all meet some of the formal criteria.

Dopamine and norepinephrine are members of a class of chemical compounds called *catecholamines*. They have in common a chemical structure that consists of a catechol nucleus — a ring of six carbon atoms to which are attached two adjacent hydroxyl (OH) groups — and an ethylamine (C-C-NH_2) sidechain. It has been found that reacting nervous tissue with formaldehyde vapors causes neurons that contain catecholamines to emit fluorescence in a green wavelength. The technique, called fluorescence histochemistry, has shown the structure of norepinephrine-containing neurons in some detail: the cell often has a long axon studded with many varicosities, or swellings. Since neurotransmitter compounds are released from these varicosities into synapses, they allow a single neuron to communicate with thousands of other cells.

Fluorescence histochemistry reveals that there are at least three main axon bundles, or nerve tracts, containing norepinephrine in the brain and the spinal cord (shown in part on pages 30-31). One tract has cell bodies located in the hindbrain, the area of brain immediately adjacent to the spinal cord. These cell bodies give rise to long axons that descend in the spinal cord to form synapses with motor neurons — nerve cells that control muscles and glands. The other two tracts innervate various cell masses in the most anterior parts of the brain. These two tracts appear to be involved in different bodily functions: one bundle, called the dorsal noradrenergic bundle, appears to be concerned with fine coordination of movement, alertness, and emotion, whereas the other, the ventral noradrenergic bundle, appears to be involved in the regulation of blood pressure, reproduction, body temperature, hunger, thirst, and other visceral functions.

Dopamine appears (also by fluorescence histochemistry) to be the neurotransmitter in three main nerve tracts in the brain: the nigrostriatal, the meso-limbic, and the tubero-infundibular dopamine systems. The nigrostriatal bundle has cell bodies located in the midbrain; these cells send axons into cell masses deep in the forebrain. Damage to this tract appears to be related to the development of Parkinsonism — a disease characterized by uncontrollable tremor, rigidity, and paucity of bodily movements. The meso-limbic system also has cell bodies located in the midbrain, but it sends projections to forebrain areas that

appear to mediate the sense of smell in rodents. Its precise role in humans remains to be determined. The tuberoinfundibular system has cell bodies located in a forebrain area called the hypothalamus; the results of some investigations have shown that these neurons may play an important role in the release of hormones from the pituitary gland.

Synthesis and Inactivation of Catecholamines

How well do norepinephrine and dopamine satisfy the criteria for brain neurotransmitters? It is known that the two compounds are synthesized within certain neurons in brain. The cell bodies of these neurons can make the three enzymes needed for the conversion of the amino acid tyrosine (a component of dietary protein) into the putative neurotransmitter norepinephrine. The first step in the synthesis, as shown on page 32, involves the hydroxylation of tyrosine — the addition of an OH group — in the so-called meta position on the carbon ring. This reaction is catalyzed by the enzyme tyrosine hydroxylase, and is considered to be the rate-limiting step in the biosynthesis of the catecholamines. The product formed is 3, 4-dihydroxyphenylalanine (L-dopa), a compound that has been shown to be effective in ameliorating the symptoms of Parkinson's disease. Dopa is decarboxylated — that is, a COOH group is removed — to form 3, 4-dihydroxyphenethylamine (dopamine). The enzyme involved is dopa decarboxylase. We noted earlier that dopamine appears to be a neurotransmitter in some neurons of the brain. In norepinephrine-containing neurons, however, dopamine undergoes one further transformation: it is hydroxylated by the enzyme dopamine-beta-hydroxylase to form norepinephrine.

With regard to the second criterion, it has been shown that norepinephrine is taken up and concentrated in the axon terminals of certain brain and peripheral neurons. The electron microscope has revealed that these terminals contain large numbers of vesicles with dark, granular cores. The vesicles appear to be the storage sites for norepinephrine in the presynaptic neuron. When photographic plates are exposed to tissue treated with radioactively labeled norepinephrine, it can be seen that the silver grains developed by radiation from the labeled norepinephrine are localized primarily over the vesicles. Similar techniques have not been so useful for localizing dopamine in "dopaminergic" neurons, inasmuch as this compound is also found in "noradrenergic" neurons as a precursor substance.

The third criterion concerns inactivation of the neurotransmitter after it has had its effect on the postsynaptic cell. One of the ways in which the action of a transmitter is terminated is by its enzymatic transformation into a less active compound. Two enzymes appear to play a role in the inactivation of norepinephrine and dopamine — catechol-O-methyl transferase and monoamine oxidase. Probably the most important mechanism for dopamine and norepinephrine inactivation is by their recapture into the presynaptic neuron, where they can be re-stored for possible re-release. This neuronal uptake system is highly selective for norepinephrine or compounds that structurally resemble it.

Drug Effects on Neurotransmission

A knowledge of the chemical mechanisms underlying neurotransmission has led to the development of a number of drugs that appear to have specific effects on synaptic conduction.

Enhancement of chemical neurotransmission can now be achieved in several ways: Administration of precursor compounds (such as L-dopa in the case of the catacholaminergic neurotransmitters) increases the stores of releasable neurotransmitter, and presumably increases the total number of molecules that might interact with postsynaptic cells. Administration of drugs such as amphetamine promotes the release of neurotransmitters while blocking their reuptake into presynaptic neurons. Other drugs (such as apomorphine or isoproterenol) appear to interact with postsynaptic receptors on effector cells, and thus stimulate them directly. Yet other drugs (such as pargyline) block the action of the various degradative enzymes that would otherwise metabolize the transmitter molecules into biologically inactive compounds.

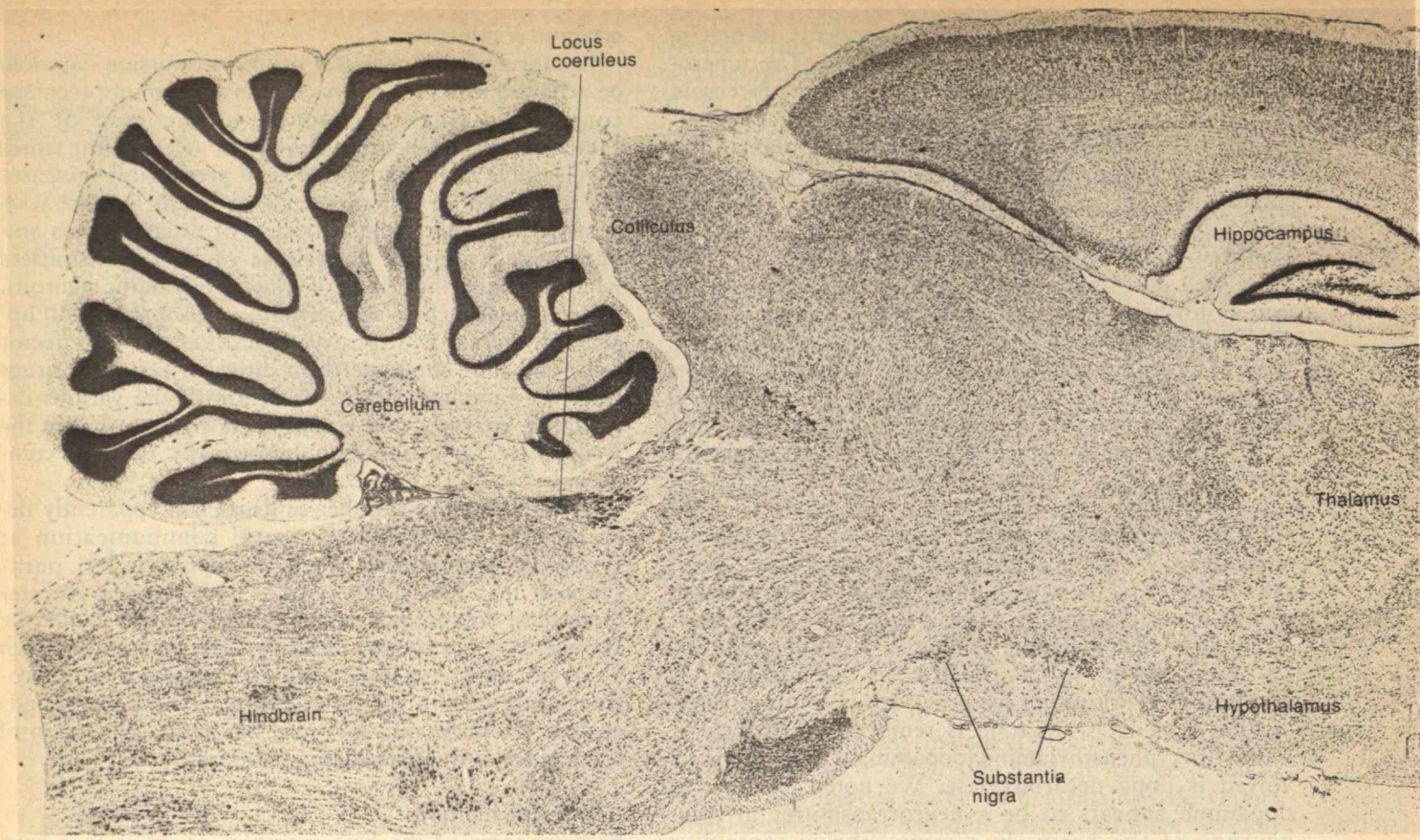
A similarly large number of drugs can apparently decrease the probability of neural communication at synapses. Compounds such as alpha-methyl paratyrosine may block the synthesis of neurotransmitter molecules; compounds such as reserpine may block the storage of neurotransmitter in vesicles; compounds such as gamma-butyrolactone may block release of neurotransmitter from presynaptic terminals; and compounds such as the phenothiazines may block the interaction of transmitter with postsynaptic receptors.

The Amphetamines

Perhaps some of the best examples of drugs that have been found useful for treating a variety of physiological and behavioral disorders are the amphetamines. These drugs are neither the most studied nor the most widely used compounds today. However, the experimental use of these agents has contributed greatly to our understanding of how the nervous system works, and has led to the development of better drugs.

Almost all the amphetamines' effects were discovered during the 1930s. In 1932, Smith, Kline, and French Laboratories marketed the drug as an essential component of the Benzedrine inhaler sold over-the-counter for the relief of nasal congestion. It soon became obvious that the drug had many other effects, and its stimulant properties were used as early as 1935 for treatment of narcolepsy, a rare disease in which an individual uncontrollably falls asleep several times a day. In 1938 it was noticed that two narcoleptic patients treated with amphetamines developed psychotic reactions that closely resembled paranoid schizophrenia. This drug-induced psychotic reaction has since been studied as a possible means for understanding the biochemical basis of mental disorders like mania and schizophrenia. In 1939 it was also observed that amphetamine-treated narcoleptic patients had decreased appetites and lost weight when they were under medication. This anorexic, or appetite-suppressing, effect of the drug made the amphetamines the treatment of choice for obesity during the 1950s and 1960s.

In 1937 Bradley observed that amphetamine apparently improved the behavior of hyperkinetic children. Many of these children treated with the drug have shown an increased ability to concentrate and have improved their behavior at home and in the classroom. However, the indiscriminant use of these drugs for treating such children has touched off a controversy among physicians, parents, and educators that is still extant today.



Pharmacology of the Amphetamines

Amphetamine is unusual in that its chemical structure (shown on page 33) is simple compared with those of other psychoactive drugs. Its biological activities, however, are multiple and complex. Many of these activities appear to be intimately related to the basic chemical structure of the molecule.

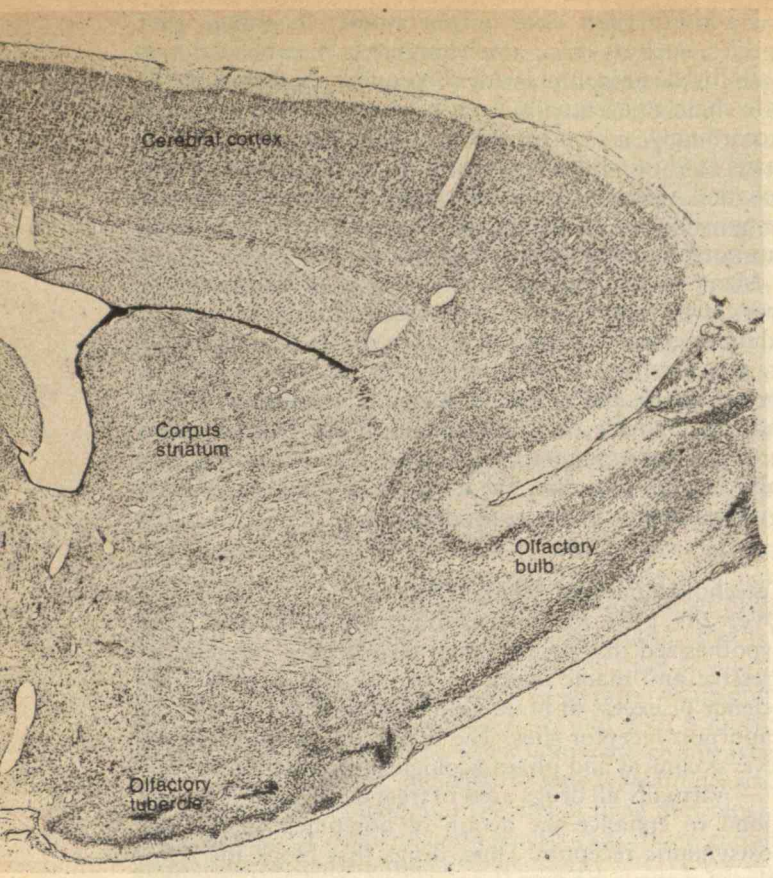
One research strategy employed in pharmacology is to examine the biological activity of a compound after modifying its chemical structure. These *structure-activity* studies suggest that there are four basic properties of the amphetamine molecule that add to its biological potency. First, the six-carbon ring of amphetamine contains no chemical groups other than hydrogen atoms. If groups such as a hydroxyl radical are added to the phenyl ring, the ability of the drug to accumulate in the brain from the circulatory system is greatly diminshed, this because the brain is more selective than other bodily organs in its ability to accumulate drugs or other blood constituents. If a drug is electrically charged, if it is insoluble in lipid, or if its size is too large, then the drug will not easily cross the so-called blood-brain barrier. The ability of amphetamine to cross this barrier is decreased when substitutions occur on the carbon ring of the parent molecule.

The second structural attribute of amphetamine that appears to be important for its potency is the location of the amino group (NH_2) in relation to the methyl (CH_3) group on the molecule's side chain. In a number of species, including man, one of the major means of inactivating amphetamine is by removing the amino group. The process (called deamination) occurs largely by means of enzymes in the liver, and the resulting deaminated metabolite of amphetamine has been shown to have less biological activity than the parent compound. It appears that the close proximity of the methyl to the amino group sets up weak binding forces within the molecule that retard the deamination of amphetamine, and therefore allow more of the active molecules to reach their sites of action. In addition, the methyl group also makes amphetamine a weak inhibitor of the degradative enzyme monoamine oxidase. This property may also add to the neuropharmacological potency of the drug.

The third important property of amphetamine involves the length of its sidechain. Two carbon atoms separate the carbon ring from the amino group, and this physical separation is crucial for many of the pharmacological and biochemical properties of amphetamine, presumably because this two-carbon distance is similar to that of many of the putative neurotransmitters released by neurons upon which amphetamine is thought to act.

Finally, it has been shown that the addition of various chemical groups at locations on the two-carbon side chain greatly alters the predominant physiological or behavioral activity of the parent compound. If, for example, the parent amphetamine molecule is altered by placing an oxygen on the side chain (especially in the position of the carbon atom to which the methyl group is bound), or if the side-chain amino group is replaced with bulky groups (such as benzene), a drug is formed that has less stimulant effect than the parent molecule, but has greater effect on appetite. Fenfluramine, for example, has been shown to have anorexic potency equal to or greater than that of amphetamine, although it has little effect as a stimulant.

On the other hand, by changing amphetamine's side



A cross-section of rat brain, taken parallel to the plane that divides the brain into symmetric halves. Each dot is a cell body. (The dark band coursing through the cerebellum is the cerebellar cortex, the brain's most densely packed community of cells.) Two cell masses labelled in the illustration are known to utilize a neurotransmitter discussed in this article. The *locus coeruleus*, a dark triangular cell mass just beneath the rat's cerebellum, is composed of cells that utilize the neurotransmitter norepinephrine. Fibers from this tiny nucleus can be found terminating in a vast area of brain that includes the cerebellum, the cerebral cortex, and the hippocampus. The *substantia nigra* (more specifically, its so-called zona compacta), near the bottom center of the illustration, is composed of cells that utilize the neurotransmitter dopamine. From here, fibers project to the corpus striatum. The forward trajectory of these fibers (mingled with others) is suggested by the pallisadic appearance of cells in the hypothalamus, which shows that fibers sweep through their midst. The rat brain was stained and sectioned by Dr. Miles Herkenham at M.I.T.'s Department of Psychology, and photographed for Technology Review by Joseph A. Gagliardi, Jr., at Harvard Medical School.

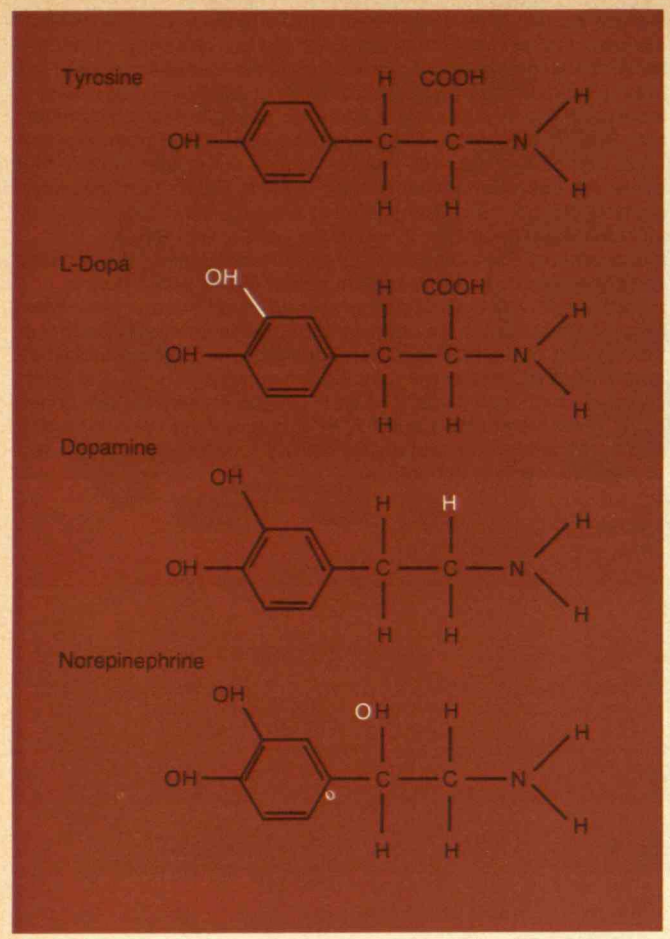
chain into a so-called heterocyclic ring system, such as piperidine, oxazolidinone, or pyrrolidine, the stimulant property of the drug can be retained, whereas the anorexic effect is greatly attenuated. Some of the resulting compounds, such as magnesium pemoline or methylphenidate, have been found useful in the treatment of childhood hyperkinesia.

Interest (both clinical and experimental) has recently been aroused by a number of other substituted amphetamines that have been shown to have psychotomimetic activity: the addition of methoxy (CH_3O) groups to the carbon ring of the parent molecule results in drugs with hallucinogenic activity that is often indistinguishable from that of mescaline.

The Metabolism and Action of Amphetamine

To understand how drugs like amphetamine produce such profound biochemical, physiological, and behavioral effects in humans and other mammals, it is necessary to understand what happens to a drug once it enters the body. However, no data exist regarding the distribution of amphetamine in different tissues or organs in human beings. And since there are tremendous variations among species in the metabolism and distribution of most drugs, what may be true for a given species and drug may not apply to the human case. Still, evidence provided from studies of animals such as rodents and primates has shown that amphetamine is rapidly absorbed into the bloodstream from the gastrointestinal tract — primarily from the small intestine. Once amphetamine is absorbed into the bloodstream, the drug rapidly distributes to a number of tissues in the body, with the greatest concentrations found in the kidneys, lungs, liver, and brain.

It now seems clear that many of the physiological and behavioral effects of the amphetamines and related compounds are the direct result of the drug's actions on brain and peripheral catecholamine-containing neurons. Amphetamine appears to affect catecholaminergic neurotransmission in at least two primary ways. First, administration of the drug appears to block the reuptake of norepinephrine or dopamine into the presynaptic terminals, apparently by interfering with the neuronal transport mechanisms for these neurotransmitters. Second, amphetamine stimulates the release of catecholaminergic neurotransmitters. Hence, both molecular actions of the drug result in an increased amount of catecholamines being released into the synaptic cleft, and in a correspondingly increased probability of communication for neurons that secrete the catecholamines. Although the rather diverse effects of the amphetamines may at first glance appear to be unrelated, it now seems likely that in each instance amphetamine is acting to alter catecholamine neurotransmitter function at specific loci in the brain and peripheral nervous systems. Structural alterations in the parent amphetamine molecule appear to modify the main effects of the drug by changing the primary site where it acts; in fact, the methoxylated, psychotomimetic amphetamines seem to produce a large portion of their effects by their action not on catecholamine-containing neurons, but on brain serotonin-containing neurons. Similarly, the addition of a CF_3 group to the carbon ring, as in the case of fenfluramine, or of a Cl group, as in the case of para-



The synthesis of two putative neurotransmitters — substances that are believed to mediate communication between nerve cells. The two are catecholamines — molecules with a six-carbon ring bearing two adjacent hydroxyl (OH) groups and an ethylamine (C — C — NH_2) sidechain. White is used in the illustration to emphasize the molecular change involved at each step. The synthesis begins with the amino acid tyrosine, a component of dietary protein that is selectively absorbed by many cells in the brain. Tyrosine is converted by so-called catecholaminergic nerve cells to l-dihydroxyphenylalanine, or l-dopa, through the addition of a hydroxyl group to the molecule's six-carbon ring. The reaction is catalyzed by tyrosine hydroxylase, an enzyme found exclusively in brain cells that synthesize catecholamines. L-dopa is next converted to the putative neurotransmitter dopamine (l-3, 4-dihydroxyphenylethylamine) by the action of dopa decarboxylase, an enzyme that removes the terminal carboxyl (COOH) group. Still other neurons (noradrenergic and adrenergic cells) contain an additional enzyme, dopamine-beta-hydroxylase, that converts dopamine to another putative neurotransmitter, norepinephrine.

chloroamphetamine, makes these molecules into toxins that destroy serotonin-containing neurons, at least in rats.

As is true for most drugs, the primary method of inactivation for amphetamine is via enzymes in the liver. Tremendous interspecies differences in the metabolism of amphetamine have been observed, but there appear to be at least two major pathways for the metabolism of amphetamine in mammals: In some species, such as the rat, amphetamine is hydroxylated on the carbon ring and is subsequently excreted by the kidneys. Some amounts of this metabolite are further hydroxylated on the side chain to form norephedrine, a compound that has less biological activity than does amphetamine. In some other species, such as man, amphetamine is metabolized partially by deamination, with subsequent oxidation of the side chain to eventually form benzoic and hippuric acid. Accordingly, assays for cases of stimulant abuse in humans (and race horses) measure the accumulation of benzoic and hippuric acid in the urine. At present, the tissue responsible for oxidizing the deaminated amphetamine has not been identified in humans.

Many factors influence the amount of amphetamine that can be found in various tissues, including the route of administration (whether it is taken orally or injected intramuscularly or intravenously), the nutritional state of the organism, and so on. For example, it has been shown that the half-life of amphetamine in the human blood stream is approximately eight hours if subjects are maintained on an acid diet, but it can be as long as 22 hours with maintenance on an alkaline diet.

Catecholamines and Mental Diseases

Over the past ten years, many investigators have hypothesized that some mental disorders — notably depressive and manic states — are associated with a deficiency or excess of brain catecholamines at functionally important receptor sites. The hypothesis is supported by several clinical and pharmacological observations:

— Virtually all drugs used to treat depressive illness are found to enhance the action of norepinephrine at the postsynaptic receptor. Thus, drugs that block the reuptake of norepinephrine at presynaptic terminals (amphetamine) or drugs that block the metabolism of norepinephrine (monoamine oxidase inhibitors) alleviate the symptoms of mental depression. Conversely, drugs that cause depletion or inactivation of norepinephrine (reserpine, for example) cause depression in susceptible individuals.

— In some studies, low levels of norepinephrine and its metabolites have been measured in the urine and cerebrospinal fluid of patients with depression; as behavior improves, urinary levels steadily rise toward normal. However, these observations have not been confirmed by all clinical studies. Furthermore, the interpretation of experiments measuring changes in catecholamine metabolites in body fluids is hampered because only a fraction of the metabolite present originated from transmitter release within the central nervous system. Biochemical analysis of brain tissue at autopsy can sometimes overcome these problems.

— Drugs that enhance the release of norepinephrine (e.g. amphetamine) have been found to worsen the behavior of manic patients, while drugs that may reduce synaptic concentrations of catecholamines (lithium salts) tend to alleviate such abnormal behavior. Moreover, the ingestion of large doses of amphetamine (for example by addicts) creates a clinical picture that is often indistinguishable from acute paranoid schizophrenia. Both conditions are characterized by auditory and visual hallucinations, delusional thinking, and stereotypy — stereotyped, repetitive, and compulsive behaviors. Amphetamine administration can produce stereotypy in many species other than man. Rodents, for example, display continuous sniffing, licking, biting, and gnawing behaviors, while chimpanzees groom and pick at their skin and exhibit side-to-side looking movements. Human amphetamine addicts often engage in similar types of behaviors, including continuous grooming and picking.

They will spend hours taking apart objects and reassembling them in a ritualistic, compulsive manner.

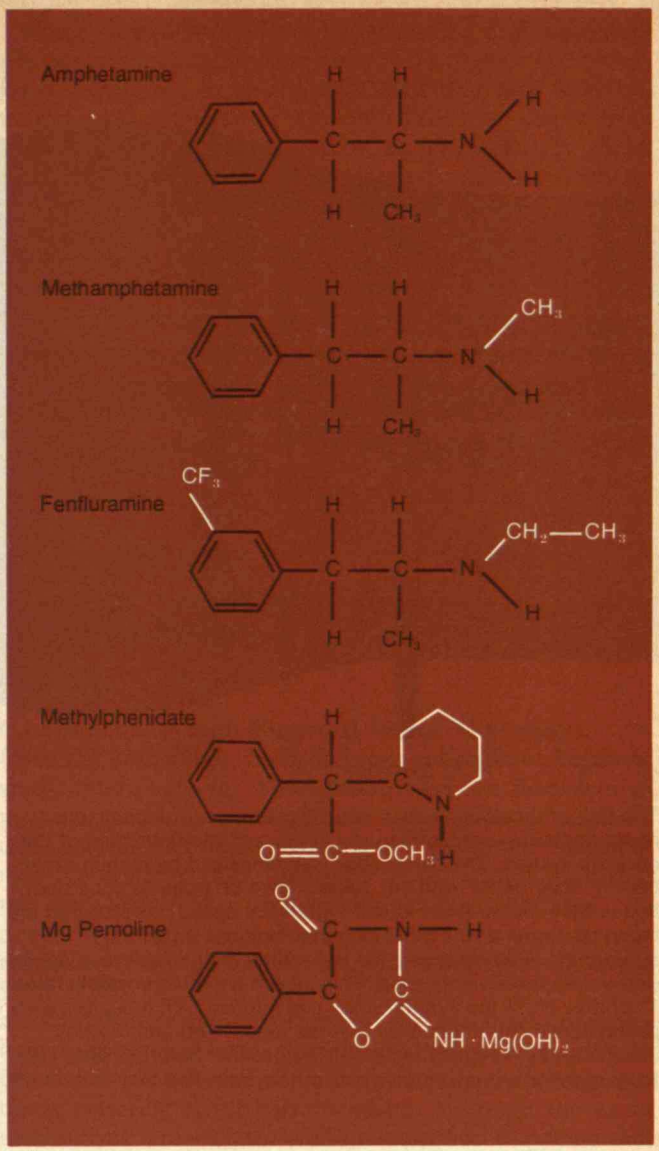
An abundance of recent evidence suggests that drug-induced stereotypic behavior — at least in rodents — is mediated by dopamine-containing neurons in brain. Thus, the ability of amphetamine to induce or exacerbate psychotic behavior in humans may be related to its specific ability to potentiate dopamine neurotransmission by promoting the release, and by blocking the reuptake, of that neurotransmitter. The evidence takes the following forms: Stimulation of brain structures containing dopaminergic neurons can provoke the development of amphetamine-induced stereotypy; ablation of these structures can inhibit it. Drugs that inhibit dopamine neurotransmission are found to attenuate amphetamine-induced stereotypy, and are also found to be effective in the treatment of schizophrenia. As an example, the phenothiazines (e.g., chlorpromazine) and butyrophenones (e.g., haloperidol), which are potent dopamine-receptor blocking drugs, effectively attenuate stereotypy and other symptoms of psychosis, either drug-induced or endogenous. On the other hand, methylphenidate, a drug with a powerful stimulating action on dopamine-containing neurons, can greatly exaggerate psychotic symptoms at a lower dose, and with a shorter latency, than amphetamine when administered intravenously to schizophrenic patients. L-dopa (the amino acid precursor of dopamine) and cocaine (a drug that blocks the reuptake of catecholamines) also exacerbate certain symptoms of schizophrenia.

Catecholamines and the Regulation of Appetite

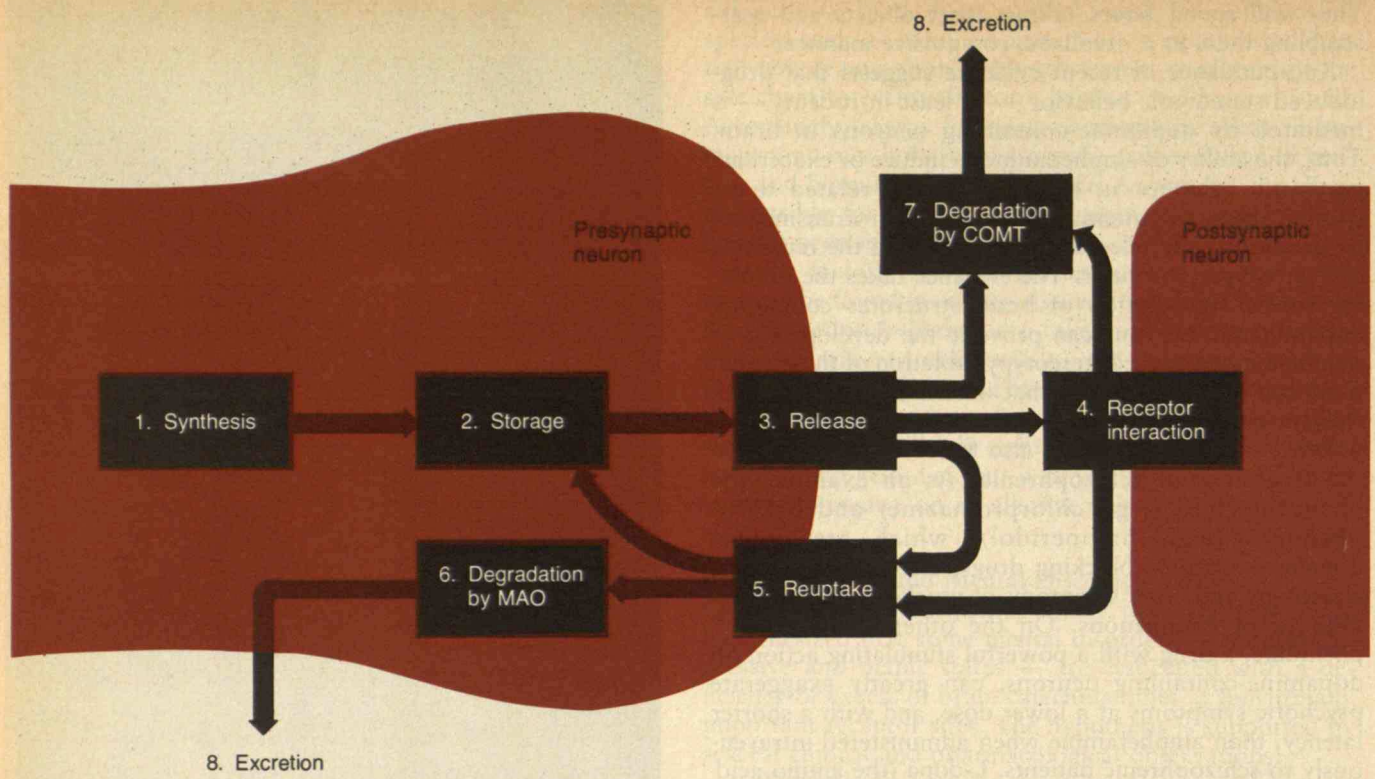
One of the most prevalent medical problems in the United States today is obesity. It has been estimated that approximately 10 per cent of the American population is overweight, but less than 10 per cent of this group appears to have glandular or genetic causes for the problem. Although the reasons for overeating are often elusive and may involve the idiosyncrasies of the patient's psychological makeup, a study conducted in 1948 reported that 92 per cent of physicians treating obesity used amphetamines as the prime therapeutic agent. Furthermore, 65 per cent of all patients seeking medication for obesity were given amphetamine.

The treatment of obesity with amphetamine is currently in disfavor among most physicians, due to the large potential for abuse of the drug, and because drug tolerance develops: the rate of weight reduction cannot be sustained unless the dosage regimen is increased. Accordingly, amphetamine has been largely ineffective as a means of controlling appetite for long periods of time in humans, but experimental work with the drug has greatly increased our understanding of the brain mechanisms that may be involved in the regulation of food consumption in normal humans. It has also contributed to our knowledge of the mechanisms underlying pathogenic obesity.

Probably several systems in the brain play some role in mediating body weight and food and water intake in animals and humans; however, no single region of the brain has received as much attention with respect to appetite regulation as has the structure known as the hypothalamus. The hypothalamus is optimally situated in the brain to receive information regarding the nutritional status of the organism: hypothalmic neurons receive information via axons ascending from the brainstem and descending from many forebrain areas. In turn, hypothalamic neurons communicate with the pituitary gland, and also give rise to fibers that travel up and down the rest of the brain. It has been known for quite some time that lesions or tumors confined to one cell mass — one "nucleus" — in the hypothalamus (the ventromedial nucleus) are associated with overeating and obesity in



Amphetamine and four of the drugs derived from it. In each case, what remains of the parent amphetamine molecule is shown in black; the structural alterations appear in white. Amphetamine itself (the first molecule in the illustration) has many effects in humans; it is, among other things, a stimulant and an appetite-reducing agent. The amphetamine molecule bears a strong resemblance to the putative neurotransmitters dopamine and norepinephrine, whose structures are shown on page 32. When a methyl group (CH_3) is substituted for a hydrogen atom, as shown in the second molecule, amphetamine becomes methamphetamine, or "speed," a widely abused drug of far greater stimulant potency than the parent compound. In fenfluramine (third molecule), amphetamine's amino group (NH_2) has been altered to a considerably bulkier group. The appetite-reducing effect of amphetamine is retained, but the stimulant effect is reduced. However, the addition of the CF_3 group to the molecule's carbon ring has turned the molecule into a toxin that destroys brain cells that use serotonin as their transmitter. In methylphenidate (marketed as Ritalin®; fourth molecule) and magnesium-pemoline (Cylert®; fifth molecule) the sidechain of the parent amphetamine molecule is altered to a complicated ring structure; these drugs retain a stimulant effect, but have an attenuated appetite-reducing ability.



The fate of a catecholamine neurotransmitter — dopamine or norepinephrine — according to our current understanding of the nervous system. The transmitter is synthesized by certain brain cells in accordance with the steps shown on page 32 (box one), and is then stored (two) in cell organelles called vesicles that are found clustered at the cell's terminal regions. Under the appropriate circumstances, the transmitter molecules are released (three) into the synaptic cleft. They now have three possible fates: They may cross the synaptic cleft and interact with receptors on a postsynaptic cell (four); they may be recaptured and thereby inactivated by the presynaptic cell (five), either before or after they have reached a postsynaptic cell; or they may find their way out of the synapse and be metabolized to a biologically inactive compound by the enzyme catechol-O-methyl-transferase (seven). Some of the transmitter recaptured by the presynaptic cell is returned to storage; some is metabolized by the enzyme monoamine oxidase (six). Eventually, the metabolites are excreted by the kidneys (eight). Many drugs are believed to affect the nervous system by acting to help or hinder specific stages of neurotransmission. Reserpine, for example, blocks the storage of catecholamines in vesicles (box two) and thus leaves them unprotected from degradation by MAO (six). A partial listing of drugs and their actions is given in the accompanying table.

animals and humans; damage to another nucleus (the lateral hypothalamus) results in starvation and death. Animals with lateral hypothalmic lesions will eventually "recover" from the effects of these lesions if they receive appropriate postoperative care for long periods of time. However, these animals still show several deficits in regulating food and water consumption, and these deficits appear to be permanent.

For quite some time a "dual-center" theory of appetite regulation was accepted by most investigators as explaining the brain's method of integrating bodily signals regarding hunger and satiety. In brief, this theory proposed that the ventromedial and lateral hypothalamic nuclei inhibited one another, the ventromedial "satiety center" serving as a brake for hunger, the lateral "feeding center" providing stimuli for the organism to commence eating. Amphetamine appears to exert its anorexic effects by altering the activity of neurons in the lateral hypothalamus. Somewhat paradoxically, direct injection of amphetamine into the lateral hypothalamic areas of rats produces anorexia in hungry animals, apparently by causing the release of norepinephrine from neural terminals synapsing on cells in this area.

Although the dual-center theory was the dominant hypothesis concerning hunger and satiety, more recent research has emphasized a "systems" rather than a "centers" approach to brain function. There is an increasing tendency among neuroscientists to emphasize the various interrelations among various brain areas, rather than the activity of single, isolated clusters of neuronal cell bodies, for the regulation of behavior. In fact, the ventromedial and lateral hypothalamic nuclei are not isolated centers; rather, the axons of dopamine-, norepinephrine-, and serotonin-containing neurons innervate or traverse these areas, and interconnect the hypothalamus with the rest of the brain and the peripheral nervous system. It now seems clear that damage to these nuclei following lesions or tumors destroys such axons as well, and this damage may be the critical factor that accounts for loss of appetite regulation, and for a decreased ability of many drugs to curb appetite.

A number of studies have demonstrated that the ability of amphetamine to suppress appetite occurs mainly by a reduction in the amount of food, and thus calories, consumed, and is not related to the increased psychomotor stimulation produced by the drug. However, the stimulant side-effects of amphetamine, added to the potential for abuse of the drug, contributed to its discontinued use as an anorexic agent. The Food and Drug Administration has recently approved the use of other amphetamine analogues that have potent anorexic effects but lack the stimulant side-effects. It remains to be determined whether some of these new compounds will prove effective in controlling human obesity.

	Enhances	*Blocks*
1. Synthesis	L-Dopa* Tyrosine	α-Methyl-*para*-tyrosine Disulfiram α-Methyl-dopa-hydrazine
2. Storage		Reserpine Tetrabenazine*
3. Release	Amphetamine Cocaine	Bretylium γ-Butyrolactone*
4. Receptor interaction	Bromocriptine* Apomorphine* Isoproteronal Peribedil* Clonidine	Chlorpromazine Haloperidol* Phenoxybenzamine Propranolol Pimozide*
5. Reuptake		Desipramine Benztropine* Amphetamine Cocaine Amitryptiline
6. Degradation by MAO		Pargyline
7. Degradation by COMT		

* Drugs that act primarily at dopamine-containing synapses.

Childhood Hyperkinesia

Whereas many disease states are clearly related to a dysfunction of specific neurotransmitter systems, the neural mechanisms underlying other physiological or behavioral maladies are more mysterious. Such is the case in childhood hyperkinesia. Indeed, there is a large amount of disagreement regarding even the precise diagnostic criteria for childhood hyperkinesia. Some, but not all, hyperkinetic children show high levels of basal locomotor activity, little ability to focus attention, poor impulse control, aggression, and disruptive behavior in the classroom. Are these behavioral disturbances in all cases the result of brain dysfunction, or are they largely due to emotional, psychological, and even sociological adjustment problems?

It is quite surprising that amphetamine or any of its analogues seems to work at all in ameliorating some of the symptoms of hyperkinesia. In fact, there is currently a great dispute in the literature about the drug-induced changes in the behavior of these children. Some physicians and researchers consider amphetamine's major effect to be paradoxically quieting and sedative in these children — the opposite of its effects in adults; others maintain that there is no paradox — the increased attention, altered quality of sleep, and anorexia observed in children treated with the amphetamines are the drug effects that have been observed in older people.

Some investigators have hypothesized that since amphetamine seemingly improves the behavior of hyperkinetic children, these children must therefore have impaired neurotransmitter systems. Proof or disproof of such theories cannot as yet be accomplished by direct tests in children, and must await confirmation elsewhere.

As yet, however, no fruitful animal models have been described — that is, no animals have yet been made by means such as brain lesions to display behavioral changes characteristic of those seen in hyperkinetic children. Hence we know little of the possible neuroanatomical or neurochemical abnormalities that might underlie childhood hyperkinesia. It seems unlikely that any animal models will be developed until some agreement can be reached on precisely what behavioral dysfunctions are observed in these children.

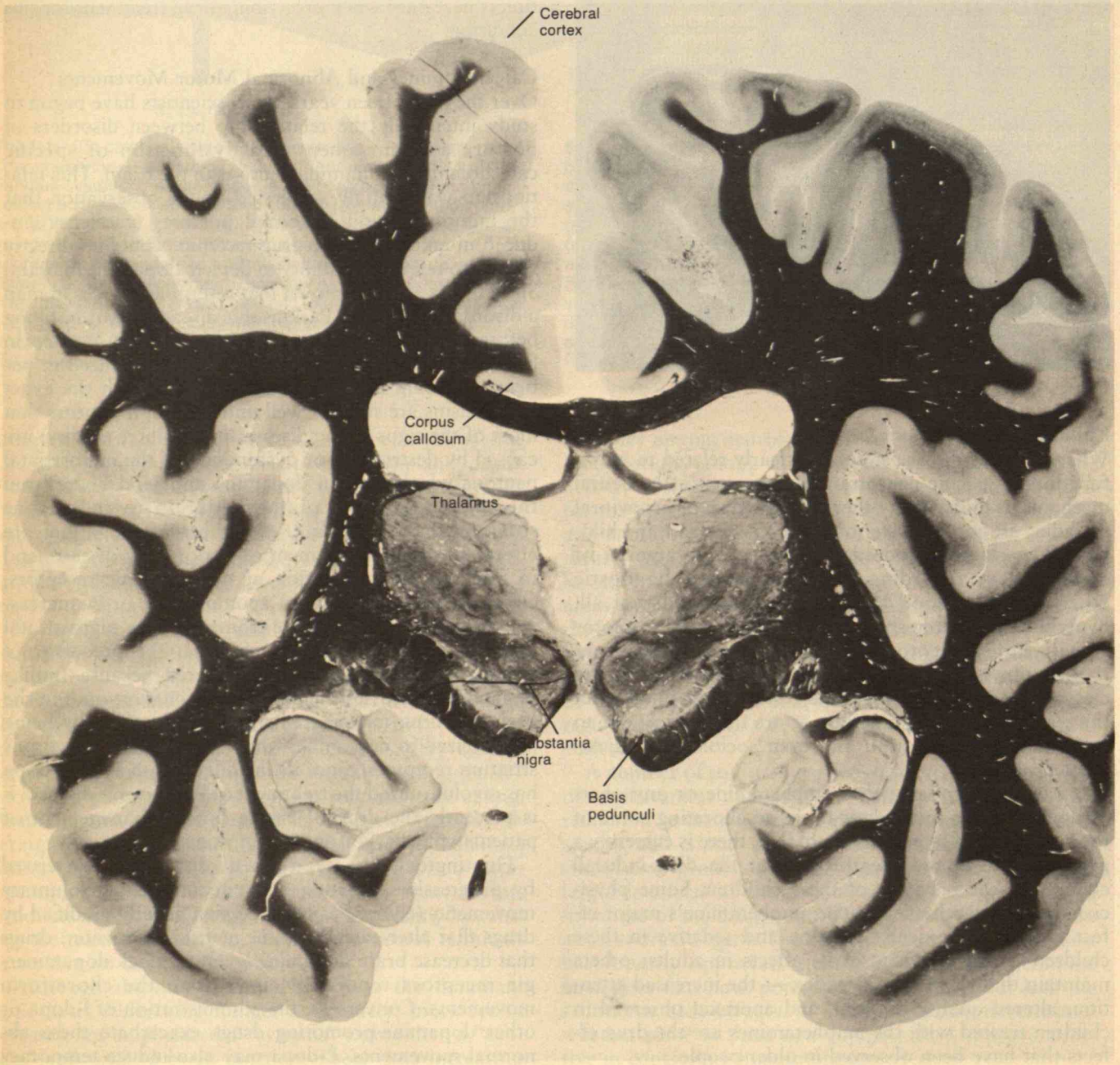
Considering the present state of our knowledge regarding the etiology of childhood hyperkinesia, and considering the lack of information concerning the long-term effects of various drugs on the development of children, it would be an understatement to suggest that extreme caution is necessary when prescribing drug treatment for this condition.

Catecholamines and Abnormal Motor Movements

Over the past fifteen years, neuroscientists have begun to study intensively the relationship between disorders of posture and movement and dysfunction of specific catecholamine-containing neurons in the brain. This relationship was intitially suggested by the observation that the immobility and abnormal postures (catalepsy) induced in animals by the drug reserpine could be directly related to reserpine's ability to deplete dopamine in brain. Since it was already known that reserpine induces in man a disorder resembling Parkinson's disease, it was not long before dopamine levels were measured post mortem in brain and were found to be dramatically reduced in patients suffering from Parkinsonism. Although the exact mechanisms are still not well understood, it appears that most of the signs of the disease (immobility, rigidity) are caused by destruction or dysfunction of the nigrostriatal neurons which contain dopamine and send fibers from the substantia nigra of the midbrain to the corpus striatum of the forebrain. A number of drugs that are effective in the management of Parkinson's disease tend to increase the stimulation of dopaminergic receptors, either by direct effects (e.g., apomorphine) or by increasing the release of dopamine from surviving nigrostriatal axons (e.g., amphetamines). L-dopa, the precursor of dopamine can be orally administered because (unlike dopamine) it crosses the blood-brain barrier; once in the brain the drug may exert its therapeutic effect by being metabolized to dopamine, which can then act on corpus striatum receptors. Since its introduction in 1967, l-dopa has revolutionized the treatment of Parkinson's disease; it is presently the drug of choice for the management of patients with Parkinsonian symptoms.

Huntington's disease, a genetic disorder characterized by progressive dementia and uncontrolled, involuntary movements (chorea) can also be significantly modified by drugs that alter catecholamine neurotransmission: drugs that decrease brain dopamine levels or block dopaminergic receptors reportedly ameliorate the choreiform movements. Conversely, the administration of l-dopa or other dopamine-promoting drugs exacerbate these abnormal movements. L-dopa may also induce temporary

The human brain, in a cross-section made at right angles to the brain's long axis. The slice, in other words, is made in the same way as a slice would be taken from a loaf of bread. It has been stained to darken the fatty substance that sheaths nerve fibers of large diameter; thus the brain's coloration is inverted. The dark areas in the photograph are the nervous system's so-called "white matter" — areas composed predominantly of nerve fibers — while the light areas are "gray matter" — areas composed predominantly of nerve cell bodies. The serpentine band at the brain's surface is the cerebral cortex — gray matter, though it is nearly white in the illustration. The dark band connecting the two cerebral hemispheres is the corpus callosum — a fiber plate, and therefore white matter. This section does not include the hindbrain and spinal cord, but it does include part of the midbrain, which lies beneath the thalamus. At the base of the midbrain is the basis pedunculi, an enormous bundle of fibers streaming away from the cerebral cortex. Just above it is a lens-shaped area of gray matter, the substantia nigra, implicated in Parkinson's disease. The section was prepared by Dr. Paul Yakovlev, and is reproduced here with his permission.



choreiform movements in some "normal " subjects who are genetically at risk for developing this disease. It has been found, however that the brains of Huntington's disease patients contain normal concentrations of dopamine and norepinephrine, which suggests that Huntingtonian symptoms may not primarily reflect a disease of catecholamine-containing neurons in brain. The recent discovery that Huntingtonian brains contain signficantly reduced levels of the neurotransmitter gamma-amino butyric acid (GABA) is likely to promote the development of drugs that potentiate transmission across GABA synapses. Perhaps such drugs will provide more specific therapy for these abnormal movements.

Recent biochemical and pharmacological studies suggest that several other diseases of the nervous system may also involve pathology at catecholamine-containing neurons (e.g., convulsive disorders and strokes). There is considerable utility to demonstrating that a particular disorder is associated with abnormal activity in specific neurotransmitter systems, since once this information is known, a variety of pharmacological strategies (such as those described above) can then be utilized in order to increase or decrease the activity at these synapses.

The neuronal and synaptic models described in this article have been quite useful in providing information about the possible neuroanatomical and neurochemical substrates that underlie a variety of normal, drug-induced, or pathogenic behaviors. The current models are obviously too simple to cover all behaviors and all disease states; it is undoubtedly true that as our knowledge increases, our model systems will become more complex. As a matter of fact, a number of exceptions and discrepancies already contradict the catecholamine synaptic model. Newer paradigms, with greater predictive efficacy, will appear as we futher our understanding of how the nervous system communicates with its environment.

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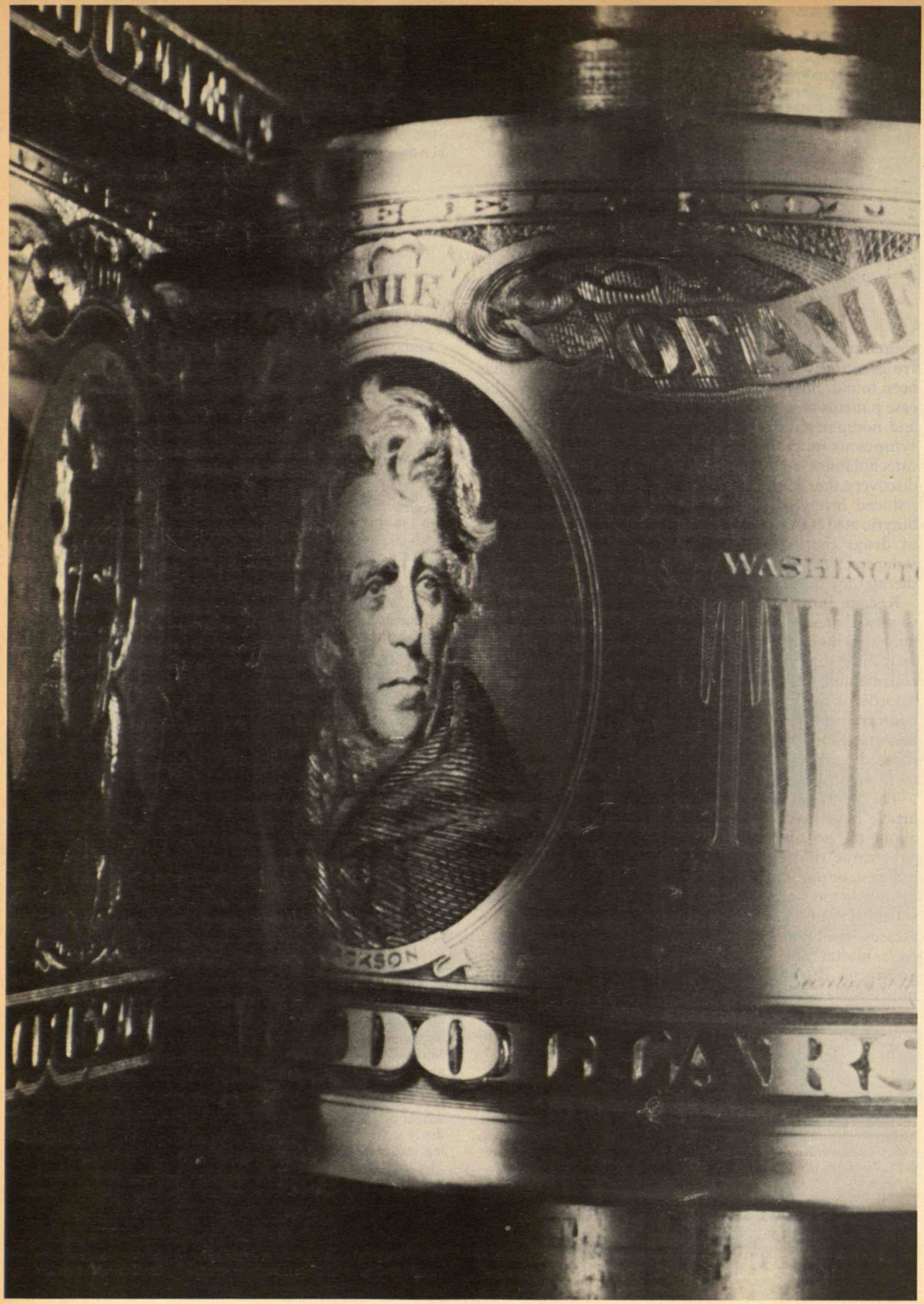
Loy D. Lytle is Associate Professor of Psychopharmacology in the Department of Nutrition and Food Science at M.I.T. He received his B.A. from the University of California at Santa Barbara, and his Ph.D. in psychology from Princeton. His research interests include the effects of nutrition on development and behavior, the neural regulation of feeding and drinking, and the synthesis and metabolism of neurotransmitters. **Michael A. Moskowitz** is Lecturer in M.I.T.'s Department of Nutrition and Food Science, and Assistant Professor of Neurology, Harvard Medical School, at the Peter Bent Brigham Hospital. He received his A.B. from Johns Hopkins University and his M.D. from Tufts University School of Medicine, and then served his medical internship and residency at the Yale University School of Medicine. His neurological training was received at Peter Bent Brigham Hospital, Childrens Hospital Medical Center, and Beth Israel Hospital, all in Boston. His research includes investigations on neurotransmitters, neuronal metabolism, and disorders of the nervous system. **Ruth H. Strauss** has been a research electron microscopist at Massachusetts General Hospital and Mallory Institute of Pathology, following her graduation from Wellesley College (A.B., biology). She has investigated pulmonary disease; the immunological events associated with reproductive biology; and amphetamine treatment of childhood hyperkinesia. In September she entered Boston University School of Medicine.



James Brian Quinn
Amos Tuck School of Business Administration
Dartmouth College

The government's anti-inflationary monetary policies have backfired, retarding research and development, discouraging investment, thus reducing productivity and spurring inflation

U.S. Monetary Policy: A Heavy Hand on Technology

In recent years the federal government has attempted to slow inflation through monetary and fiscal policies. Instead of stimulating productivity, constraining its own programs, or giving incentives for savings, it has:
— tightened money supplies and decreased credit availability;
— stimulated interest rate increases to discourage borrowing and lower demand levels;
— accepted squeezed profits, human displacements, and unemployment as costs of further reducing demand; and
— offset the harshest effects on individuals through subsidies, welfare payments, or unemployment compensation.

This approach has been politically easy to implement and presumably predictable in its effect. But it has not dealt with the basic causes of the current inflation. And it has delayed or prevented actions essential to long-term recovery.

Long-Term Investments

Most important, the government's anti-inflation strategy has tended to discourage longer-term investments — particularly those in plant capacity, producing equipment, and the search for new technologies.

High interest rates discriminate heavily against investments whose returns will be delayed or realized only over long time periods. For such long-term investments, finance (or carrying) costs increase substantially relative to the materials, labor, or service benefits of the investment. Thus, as money costs grow, many otherwise productive long-term investments arbitrarily become unattractive.

Monetary interventions can also cause other anomalous inflationary effects, in some cases actually increasing current operating costs and adding to future demands for labor and resources.

For example, increased interest costs make it harder for consumers to justify investing in better insulation, more efficient heating systems, or longer payout technologies such as solar heating. Similarly, industrial or commercial buildings will be designed to hold down initial investment costs at the expense of higher annual fuel, maintenance, or operating costs. Such decisions obviously add to already inflationary energy and service personnel demands.

The very investments necessary to break out of an inflationary cycle — increased plant capacity, cost-reducing equipment, or productivity-improving systems — become less attractive as money prices go up. Since finance costs are direct costs of such projects, they are usually included in the capital proposals justifying them.

True, expectations of inflation may cause investors to anticipate higher cash revenues, hence the *cost of capital* may not be higher at all. But consumers rarely make such sophisticated calculations in their purchases. Most companies translate increased money prices and inflationary uncertainties into higher "cost of capital cut-off points" in their budgeting for capital expenditures. And conservative management practices generally limit the extent to which speculations about future inflation can be included in revenue forecasts. The net result is to actively discourage critical investments which *would* be undertaken if money prices were low.

In fact, the primary purpose of policies which increase interest rates (usually by shortening money supplies) is to discourage expenditures which industry or individuals can postpone, and thus decrease total demand. Even during the 1950s and early 1960s, a period of low money costs, interest rate changes seemed to influence investment decisions, but not as dramatically as the large changes of recent years, as is shown by the graph on page 41.

Through 1965, money costs were a relatively minor uncertainty in the investment equation. However, the high money prices of the late 1960s began to influence investments markedly. Despite growth in real G.N.P., real investment rates remained constant from 1966 through 1971. Investment expanded again in 1972-1973 as money prices briefly decreased. Then real investment dropped again in 1974 as interest rates increased sharply. All key components of productive investment — nonresidential construction, producers' durable equipment, and real plant and equipment expenditures — responded in similar patterns. Although a complex of other factors was also at work, tight money policies clearly discouraged industry's long-term investments throughout the late 1960s and during the 1974-1975 period. This underinvestment has had definite inflationary consequences. It contributed to the capacity shortages that helped trigger the 1974-1975 inflation spiral. And it slowed U.S. productivity growth from 1965 to 1975.

Left: An engraved die at the U.S. Treasury Department's Bureau of Engraving and Printing is stamped onto a plate to produce twenty-dollar bills. Tightened money supplies has been one of the federal government's chief means of slowing inflation, but it has also injured new technology, argues the author. (Photo: Department of the Treasury)

Table 1

Interest rate increase (percentage points)	Increased return required (versus current year) if income is received in: 3 years (percentage points)	5 years (percentage points)	7 years (percentage points)
+1	3	5	7
+3	9	15	22
+5	15	27	41
+7	22	40	60
+10	33	61	95

Increases in money costs strongly discourage long-term investments, because much more future return is required to justify small interest rate increases today.

Depressed Research and Development

As monetary policies stayed relatively tight, and inflationary uncertainties increased, real levels of privately funded research and development (non-military/space) expenditures peaked in 1969 and remained constant thereafter. Once again, one can't really sort out the consequences of other factors, such as the loss of faddishness in industrial research and development. But high money costs undoubtedly forced closer scrutiny of all longer-term programs during this period. The long delays between research and development investments and their eventual returns — and the uncertainties inherent in research and development — caused these programs to suffer disproportionately when formal financial techniques were used to rank them against shorter-term options.

Thus, plant, equipment, and research and development investments all seem, predictably, to respond to changing money costs. At low interest rates borrowing and equity placements increase, supporting capital expenditure expansions. Higher investment rates continue until either the government shortens money supplies or money costs rise above levels which can be supported by anticipated economic growth.

Conversely, government policy may cool a boom by decreasing available funds until money costs become high relative to expected economic growth and/or inflation rates. Then investment slows until decreased capital demands lower money costs, monetary policy eases funds availability, or other events stimulate economic recovery. Changes in prime rates seem to have less discernible effect on investment decisions when interest levels are below 4 to 4.5 per cent. But above this, interest rates seem to have significant impact on longer term investments. Why do managements respond this way?

For each percentage point increase in money cost, for an investment to be justified, there must be an expected payout five years later over 5 percentage points higher than a current payout. Small changes in interest rates tend to have little impact on investment decisions, because estimation errors five years ahead are large by comparison. But changes greater than 4 to 4.5 percentage points become significant for the kinds of investments discussed above. Thus, if there is a 5 percentage point interest shift, an expected income received five years later is attractive only if it is more than 27 percentage points higher than a current return from the same investment. Typically, returns on major equipment are delayed one to three years; and research and development paybacks may lag five to seven years behind their initial expenditures. The table illustrates how increases in money costs — especially above about 4 percentage points — begin to discriminate against projects with longer time horizons as opposed to projects whose payoff occurs in the current year.

Fad vs. Productivity

As a result of this discrimination, by mid-1974 business had begun a distinct refocusing in private investments toward short-term, sure-fire projects with clearly demonstrable payouts. At about the same time the National Sciences Board found that 90 per cent of the respondents to its questionnaire attributed the fall-off in high risk research to an increased emphasis on short-term payoff for research and development. Inevitably, such shifts favored investments in quick cost-reduction techniques or marketing gimmicks, as opposed to more basic process or quality changes whose impact could not be measured in the short run. In specific cases, the shifts led to shortcuts and deterioration in design and production quality. Products resulting from these short-term decisions will perform more poorly and will affect their *users'* productivity negatively until they are phased out. Hence the effects of past policies will continue to be felt for at least the three to seven years it takes to replace existing products or introduce new producing systems.

The real growth benefits of style changes, marketing-fad items, or shortcuts are quickly lost in the economy. In fact, more short-term expenditures are generally needed to replace each fad with the next gimmick (or each shortcut with another quick fix) which is again quickly outdated. In the extreme, a nation could work feverishly just to replace the styles — or low-quality products — that went obsolete each year, with no real gain in wealth. Encouraging such actions hardly seems fruitful. In addition, future inflationary pressures are created when scarce material resources are wasted, rather than conserved.

By contrast, major productivity improvements, process changes, quality improvements, or technological advances can continue to lower real costs and recoup their investments for years. Yet increased monetary costs have discriminated the heaviest against precisely the expenditures most likely to be such good long-term investments. The enormous capital demands of the energy field and high government deficits seem likely to further compound these problems. Unless present trends are reversed, serious capital stringencies will develop in the next decade. Money costs will be driven up again. Private investment and technological innovation will be discouraged even more. Productivity will suffer even greater inroads from underinvestment and non-productive government programs. And the inflation spiral will be fed anew.

Interest rate changes do affect investment decisions in the economy, as shown by this composite graph. It compares the histories of interest rates, G.N.P., plant and equipment investments, and R. and D. expenditures over the 22-year period from 1953 to 1975. However, not until the stringent money policies of the 1960s did interest rates rise high enough to severely affect investment decisions. The prime interest rate was chosen as the best single indicator of the money price that private groups will respond to at any given moment. Long-term industrial bond rates have tended to move in parallel directions. (Sources: *Statistical Abstracts of the U.S.*; *National Income Accounts*; Brookings Institution computer tapes.)

MIT '77

Articles

Departments

$4 Million from Over 21,000 Alumni: "Spectacular"

A "spectacular" performance, says Edward O. Vetter, '42, President of the Alumni Association: a 21-per-cent increase in giving to the Alumni Fund in 1975-76, a total of $4,025,073, up from just over $3.3 million in 1974-75.

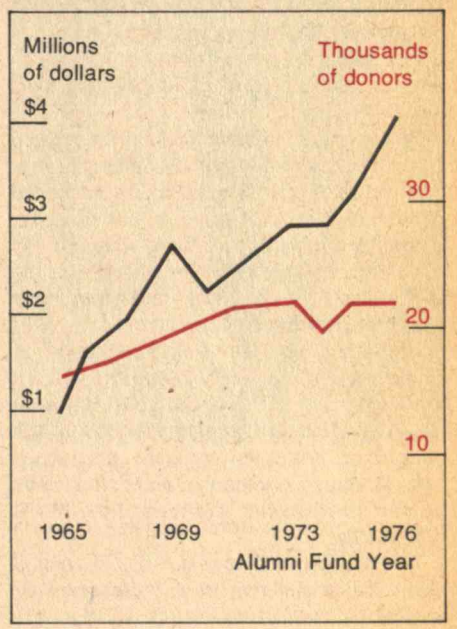
The total came from 21,357 alumni, together with 126 M.I.T. clubs, spouses, widows, and non-alumni friends. Their employers — 304 companies — "matched" the gifts of 2,200 alumni to the 1976 Alumni Fund for $251,400 of the $4.0 million total.

Fulfilling the Dollars Goal — and More

Alumni Fund goals during the second year of the M.I.T. Leadership Campaign were a 15-per-cent increase in dollars from 10 per cent more contributors. The dollars goal was fulfilled — and more — by what Frederick G. Lehrmann, '51, Director of the Fund, thinks was "one of the top two performances among Ivy League institutions." But he admits that the goal in numbers was beyond us, and the Fund settled — gratefully — for a total of contributors just 16 ahead of last year's. "The pressures of inflation" were a chief difficulty, Mr. Lehmann thinks, and he promises "a major new program . . . to achieve the 10-per-cent increase in participation next year" which is part of the Fund's five-year goal.

There are 27,360 alumni in regions of the U.S. which have been organized for personal solicitation by the Alumni Fund; 12,290 of those contributed in 1975-76. That's 45 per cent, compared to the goal of 60 per cent.

But some of the regional results were spectacular. Rockford, Ill., under Richard H. Baker III, '52, had 95 per cent participation. Among medium-sized regions, Akron, Ohio, led with 74 per cent participation (Vito A. Caravito, '62, Chairman). Rochester, N.Y., chaired by Henry R. Couch, Jr., '59, led the larger regions with 69 per cent.



The Alumni Fund goal of a 15-per-cent increase in dollars during the second year of the M.I.T. Leadership Campaign was fulfilled — and more.

Special Goals of Alumni Giving

Alumni Fund gifts in 1975-76 were designated for a wide variety of urgent Institute needs: 35 per cent was unrestricted as to use; 20 per cent was for student financial aid, 17 per cent for departmental purposes, 5 per cent for student housing, 4 per cent for extracurricular activities, 19 per cent for other purposes.

Included were gifts of $131,000 to the Independent Residence Development Fund, a revolving loan fund available to fraternities and other independent student housing groups. The total capital of the Fund now stands at $2,213,000, and 13 fraternities have borrowed from it to build, remodel, or renovate.

The two-year campaign to expand and improve M.I.T.'s sailing facilities, under the enthusiastic sponsorship of a committee headed by George Warren Smith, '26, has ended with total gifts of $303,000. Endowment for the Ellen Swallow Richards Professorship has reached $521,000 — the goal is $1 million — under "inspired leadership" of Marjorie Pierce, '22, and the first woman faculty member to be designated the Richards Professor may be announced this fall.

"Graduate" alumni — those who studied at M.I.T. for advanced degrees only — gave $380,818 to the 1975-76 Alumni Fund; there were 5,791 donors, and honors for high participation went to former students in the Departments of Chemical Engineering (39 per cent), and of Meteorology and Physics (35 per cent each).

Baker Honored Anew; Rooms or Roomettes?

Build college dormitory rooms like Pullman bedrooms, with stainless steel, fold-away facilities?

Indeed. The suspicions of students who complain about the compactness of Baker House "coffin singles" were confirmed last winter: the Finnish architect Alvar Aalto, who designed Baker House while teaching at M.I.T. in 1948 and 1949, was "enchanted" by the "contraptions" he discovered in roomettes of American Pullman cars, and he wanted the same fold-away facilities for the "wiggly building" he was planning for M.I.T.

"But we priced them out, and they were too expensive," says James R. Killian, Jr., '26, Honorary Chairman who was then President of the Institute.

This sidelight to history came into view during a modest celebration of the 25th anniversary of the dedication of Baker House in memory of Everett Moore Baker, who was Dean of Students from 1947 until his death in an airplane crash in 1950. Dean Baker's brother, sister, and son came to the Institute to present to Baker House a stained-glass medallion, a replica of a window of Chartres Cathedral, executed in Boston by Harry Wright Goodhue in the early 1930s. The medallion now has a prominent place in the common room of Baker House, a brilliant decoration which will reflect the glory and power of his brother's concerns for the advancement of man — institutional, technical, and human, said Morgan Baker.

Since it was completed, said Dr. Killian, Baker House has become "nationally recognized as one of the most important pieces of architecture completed in the post-war years." It has had a "profound effect on the development of modern architecture in the U.S. — and also on M.I.T. and upon those who have lived in it."

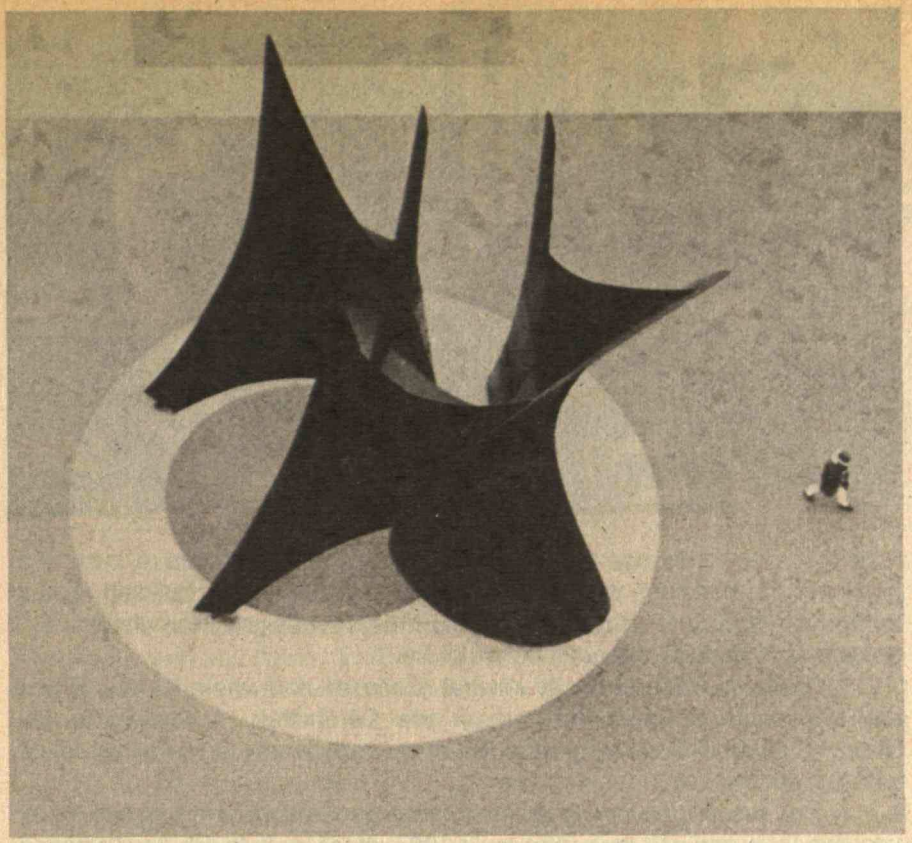
Professor M. Navi Toksoz, Master of Baker House, agreed. There have been many changes in the seven years since he and Mrs. Toksoz came to the House, but "one thing has been constant: the fellowship, kindness, dedication, and compassion among its residents and toward the M.I.T. community."

An appropriate expression of the spirit of Dean Baker himself, said Professor Toksoz.

M.I.T.'s Art: New Acquisitions; Old Controversy

M.I.T. students have been hurling epithets at campus art for years. Most recently under attack is a Louise Nevelson sculpture, *Transparent Horizon,* which arrived last winter to stand outside the new Ralph Landau (chemical engineering) Building on East Campus. Sample student comment: "I'm a resident of East Campus and regard it as disgusting that every time I walk out I have to look at such a thing . . ."

Ten years ago Alexander Calder's *Big Sail,* a sweeping black sculpture in front of the Green Building in McDermott Court, caused a similar brouhaha. Few remember — most of those dissidents have gone. Their ire was soothed by a popular belief that the construction had a practical purpose (how appropriate for the scientific mind): to break the force of the wind from the Charles that rushes through the Green Building. But that's a myth. And it hardly matters — it is "our" Calder now. Says one student, "I know it so well that I have it in my mind's eye long before I even look up at it. The fact that it is there exactly as I suspect is very consoling. I have found a friend."



"You try to find an artist whose work you know and like and feel would be an addition to the campus. And then you leave him alone."

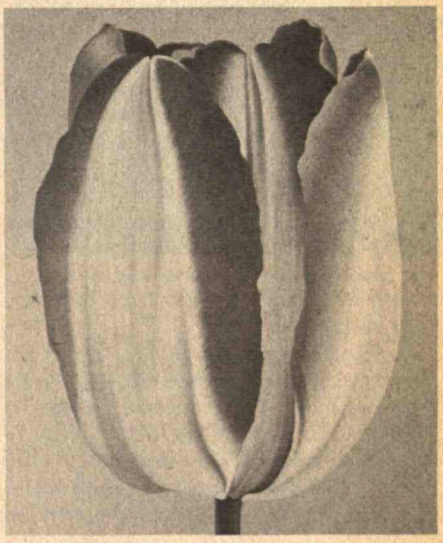
M.I.T.'s Committee on the Visual Arts has borne the brunt of the latest student hostility toward *Transparent Horizon*. The Committee chooses art not by random (as some students imply) but through a careful search to find "significant examples of a style or movement that characterizes American art during a particular phase," says Marjory Supovitz, Projects Coordinator. "Any choice involves discussion between the architect, artist, building occupants and Committee," she adds.

Since its beginning ten years ago, high standards for the Committee were set by Wayne V. Andersen, Architecture Professor and former Chairman. It was his vision that expanded the program of environmental art, so that valuable works would be integrated into the public daily experience instead of cloistered in a museum. He expanded M.I.T.'s permanent collection from 300 to 800 pieces. And under his guidance payment for art (another sore point among students) came not out of the general fund, but through a "one per cent for art" policy, stipulation that one per cent of funds raised to build or renovate a structure be used for works of art.

President Jerome B. Wiesner admits that "when you commission a work of art there is always a problem. It's like releasing a train's brakes when it's parked on a hill — you lose control of the situation. The artist is in control. But you try to find an artist whose work you know and like and feel would be an addition to the campus.

And then you leave him alone."

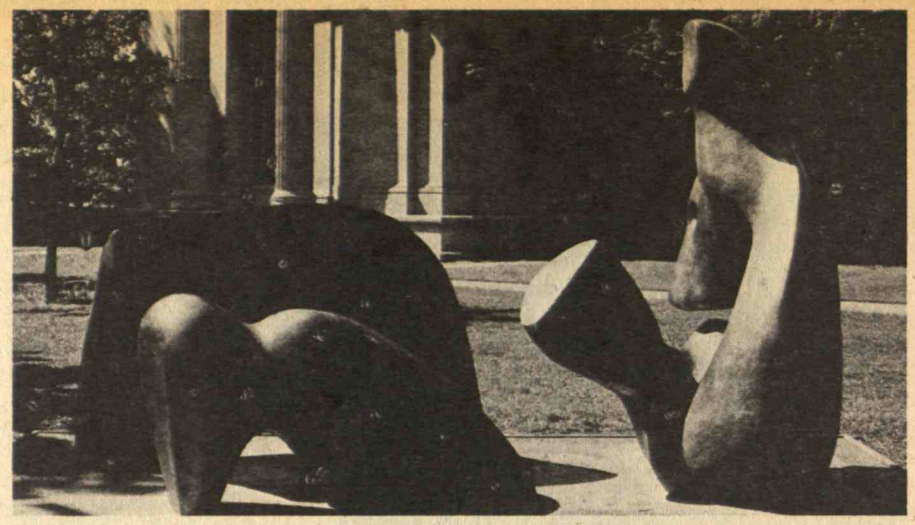
"If an artist has shown an ability to make a valuable response to a given situation without extensive outside involvement, and then if you start interfering in the process, you'll change the outcome," says Donlyn Lyndon, Professor of Architecture and new Chairman of the Committee. "What you're after is a singular commitment capable of producing extraordinary results. You don't manage that if a few people who don't have the singular commitment turn up in the process somewhere."



Opposite page: Jacques Lipchitz, *Song of Songs* 1945-1948, Bronze, 18×36×11 inches, Hayden Library, second floor; this page, top: Alexander Calder, *The Big Sail*, 1966, painted steel, 40 feet high, McDermott Court; above: Lowell Nesbitt, *Red and Yellow Tulip*, 1975, oil on canvas, 77½ × 65 inches, Building 36, third floor. (Photo above and on facing page: Roger N. Goldstein, '74)

Fail-Safe Is Not an Option

It's easy to take for granted M.I.T.'s metamorphosis. "The administration made the choice 15 years ago to enhance M.I.T.'s environment," says Dr. Wiesner. "Landscaping and planting first, so what was characterized as a



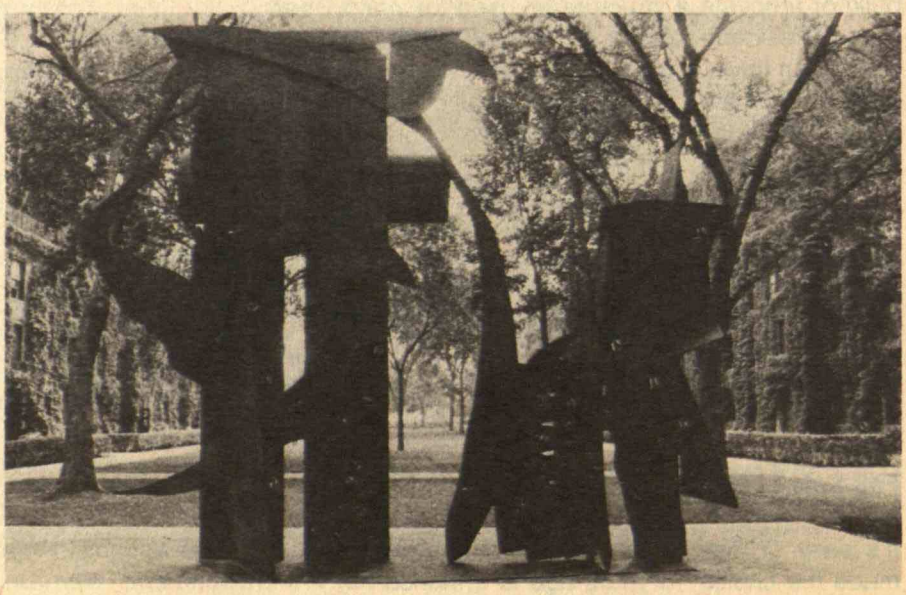
factory no longer looked that way. We also decided to improve the visual quality of the buildings with Baker, Kresge, and the Green Building, and to bring more sculpture to campus. These must be designed for where they'll go; we can't acquire old outdoor sculpture."

Students want more say in what is chosen and where it's put. (There are two student representatives on the Committee. According to Ms. Supovitz, it was difficult before the Nevelson controversy to find two students who wanted the job.)

Professor Lyndon argues that *many* generations are touched by an acquisition — and opinions change. In 1967, students in fourth-floor architecture rooms were deeply involved in designing and building the platforms and partitions that they created to vary their studio space, he explains. They saw them as a statement against the pristine and dull nature of buildings. But now it is a totally different group that inhabits that space. "Why do we have to have those things imposed upon us?" some students ask now.

"In making a building or selecting art, or setting something down for a week, or longer, you are entering into a social process. Sometimes short-term pains and long-term benefit result; and sometimes vice versa. You must do the best you can with the factors involved. There is no way you can really win by playing fail-safe," he emphasizes.

Controversy is stimulated by a substantial change in environment; people are surprised by the change. "It has always been one of the roles of art to bring new perceptions, and that means to stretch old perceptions," says Professor Lyndon. "The upset over art acquisitions might have been



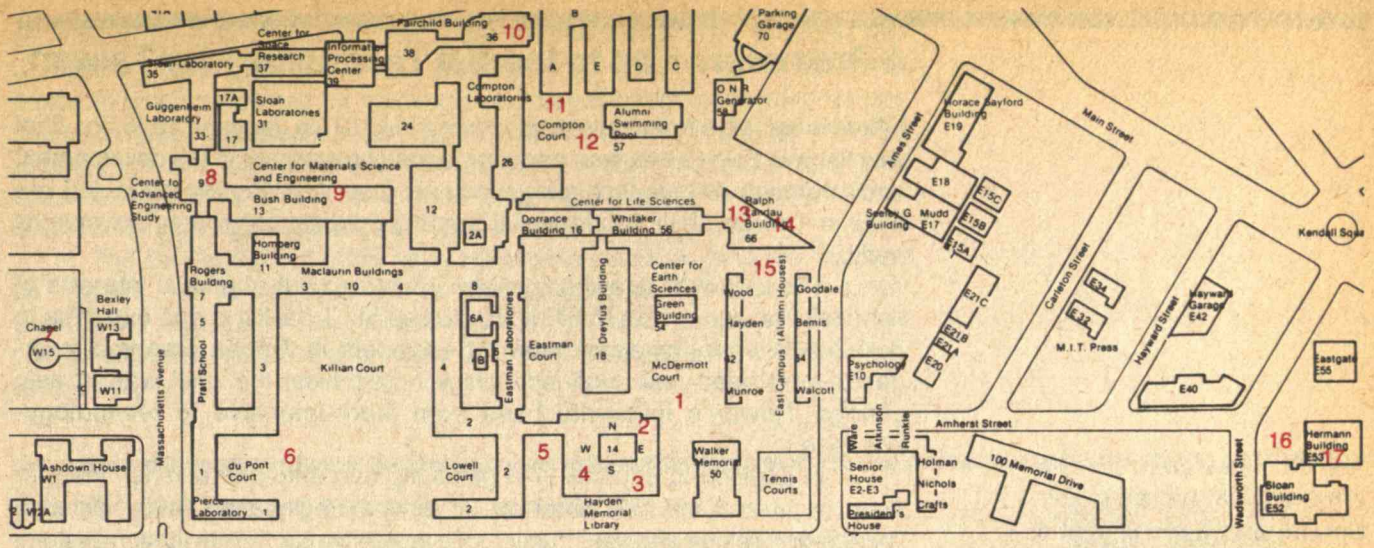
Large Scale Moore is Now in Killian Court

A recumbent figure sculpture by the internationally celebrated artist, Henry Moore, has been presented to the Institute by friends of M.I.T., and was installed late last summer in Killian Court. It is the first of Moore's monumental works to come to the New England area.

Wayne Andersen, Professor of Architecture and former Chairman of the Committee on the Visual Arts, began the procedure to obtain a Moore sculpture for M.I.T. in 1971. Mr. Moore was enthusiastic about the possibility of placing a sculpture in Killian Court when he visited M.I.T. in the spring of 1974. He felt it had the characteristics of the ideal environment for his work. "Sculpture is an art of the open air," he says. "Daylight, sunlight is necessary to it, and for me its best setting and complement is nature." One of Mr. Moore's primary concerns is that his pieces harmonize with rather than dominate their surroundings.

Mr. Moore's bronzes are cast by an ancient technique requiring a wax original for each sculpture in an edition, which he finishes himself. (No more than six casts of any of his works can ever be made.) Another cast of the piece has been sited, in Mr. Moore's private sculpture park in Hertfordshire, England. It represents a summary statement for the prime location on his land.

Three Piece Reclining Figure, Draped, is the last in a series of variations on the theme of the recumbent nude that Mr. Moore has explored for the past 40 years. His figures look as if they have been shaped as much by the forces of nature as by the artist. The finished surfaces seem to have been molded by natural erosion. And particularly in the reclining pieces, there is the embodiment of landscape.



less if M.I.T. was an institute where the arts were more easily recognized as part of the academic structure.

"In fact there are now important programs in the arts at M.I.T. and extensive student enrollment. Either we ignore the arts and what they can do — at real peril — or we make them part of our environment. If they are integral to our educational goals, then we want them to have the energy and vitality to make an impact in the same way as the other programs at M.I.T.

"We have an opportunity for the Institute to move in a way that makes the art programs stronger — in the teaching programs themselves, and in terms of our environment. When a passer-by sees a permanent piece, a temporary show, or works in progress, one thing is essential: the recognition that these are things which belong here, that effort, concern, personal commitment, and intelligence go into them — as much as into any other discipline. If people don't understand the input, there is no appreciation of the value."

What a Campus Says of its University

Increasingly artists look at not just the thing they're creating, but at the whole environment, says Professor Lyndon. Even a transient piece can invest its environment with a set of memories for those touched by it. Professor Lyndon feels that putting art out in the community where it can be experienced is of great benefit; that we can know more about ourselves if the corridors weren't so blank-walled.

"When you enter someone's house, you glance around and read your observations as a reflection of what they care about. The same is true of a university, such as the Institute. The physical environment should provide information about the social and physical activities of a place."

An example: an experiment on the third floor near the elevator in Building 7, where a window in the wall opens into the slide library so that passers-by have consciousness of the whole ongoing lecturing activity. The conference room, too, has windows into the corridor so all the policy meetings are visible to the community.

A public program, however, is clearly an issue. The lobby of Building 7 ought to be a place of performance and stage for creative work done here, says Professor Lyndon. Yet some feel that such activities impose upon them. He suggests that M.I.T. needs a place with the volume of lobby 7 that is accessible, but which also can be by-passed or isolated so performers can prepare.

Some people are disgruntled, some perplexed, some delighted over art at M.I.T. Whatever the case, the controversy appears to have had one good effect. It has made art more a part of the consciousness of the Institute, perhaps heightening the sensitivity to art at M.I.T. in ways the artists hadn't intended. — *M.L.*

Opposite page, top: Henry Moore, *Three Piece Reclining Figure, Draped,* 1976, 8 feet, 8 inches high, Killian Court; opposite page, bottom: Louise Nevelson, *Transparent Horizon,* 1975, welded steel, 20 feet high, Building 66 plaza; above: Pablo Picasso, *Figure Decoupée,* 1975, cast concrete, engraved, 11 feet high, Building E53 plaza. (Photos: Roger N. Goldstein, '74, Calvin Campbell)

The map shows the location of a selection of M.I.T.'s art: 1. Alexander Calder, *The Big Sail,* (photo page A3); 2. Emile Antoine Bourdelle, *The Tragic Mask of Beethoven,* 1901, bronze, 31 feet high; 3. Auguste Rodin, *Large Head of Iris,* 1890, bronze, 23 inches high; 4. Jacques Lipchitz, *Song of Songs,* (photo page A2); 5. Dimitri Hadzi, *Elmo-MIT,* 1963, bronze, 65 × 52 × 56 inches; 6. Henry Moore, *Three Piece Reclining Figure, Draped,* (photo, opposite page); 7. Theodore Roszak, *Bell Tower,* 1955, aluminum, 45 feet high; 8. Gene Davis, *Klondike Calendar,* 1965, acrylic on canvas, 10 × 18 feet; 9. Katherine Porter, *La Canova,* 1974, oil and wax on canvas, 94 × 76 inches; 10. Lowell Nesbitt, *Red and Yellow Tulip,* (photo page A3); 11. Jean Robert Ipousteguy, *Cénotaphe,* 1957, steel, 33 × 7 × 38 inches; 12. Beverly Pepper, *Dunes I,* 1971, corten steel, 4 × 11 × 12 feet; 13. Nicholas Schöffer, *Spatiodynamic,* 1967, stainless steel, motorized, 98 × 48 × 47 inches; 14. Jean Lurçat, *Death and the Warrior,* 1973, handwoven wool tapestry, 85 × 132 inches; 15. Louise Nevelson, *Transparent Horizon,* (photo, opposite page); 16. Pablo Picasso, *Figure Decoupée,* (photo, this page); 17. Jules Olitski, *Magic Number,* 1967, acrylic on canvas, 82 × 186 inches.

A Premature End to Inertial Technology for Taiwan

Fifteen engineers from Taiwan who came to M.I.T. in January, 1975, for what was to have been a two-year nondegree training program in the development and operation of high-technology industry (*see July/August, page 90*) are back in Taiwan, their controversial training program terminated six months early.

The idea was spawned several years ago out of mutual interests of people in Taiwan and at M.I.T. It was to use M.I.T. facilities and expertise to develop an entrepreneurial cadre of engineers in Taiwan prepared to organize and head new high-technology enterprises; the goal was to help change Taiwan's industrial base from labor-intensive to technology-intensive.

The ad hoc Committee on International Institutional Commitments: ". . . we have been unable to find convincing evidence that the primary objective of the training, as it is being carried out, is other than military, even though the . . . purpose (is said) to be the development of innovators and entrepreneurs."

In addition to courses in engineering and entrepreneurship, the program organized by the Center for Advanced Engineering Study included "hands-on" design and construction of a prototype inertial navigation system, representing a practical example of the high-technology enterprises to which the students were to devote themselves upon return to Taiwan.

The "hands-on" project was considered a key element in the teaching effort because it would enable the engineers from Taiwan — with their particular technical backgrounds — to master a very difficult field quickly. The growing commercial market for inertial navigation systems made it an attractive area for a teaching program for future entrepreneurs.

The end came late in the spring when the Munitions Control Office of the U.S. Department of State informed M.I.T. that continuing that portion of the teaching program dealing with inertial navigation "would not be in furtherance of the foreign policy and national security objectives of the U.S."

Thomas F. Jones, Jr., Sc.D. '52, Vice President for Research, suggested some other areas in which the Taiwan engineers could gain their "hands-on" experience. But in the end he and a representative of the National Taiwan University (which had contracted for the training program) decided that nothing could replace inertial navigation and agreed to end rather than try to refocus the work.

So the Taiwanese went home in July. Their government agreed to pay M.I.T. all costs incurred in the program; had it run its full two-year course, those costs would have been $917,000.

From Navigation to Guidance?

High-technology inertial navigation systems involve sophisticated mechanical and electronic components; they are manufactured and sold commercially worldwide for airplanes and ships. But they draw upon the same fundamental engineering technology that is used in the design and construction of inertial guidance systems for military ballistic missiles.

So it was that a faculty-staff-student Committee on Institute International Commitments, examining the Taiwan program in detail last spring, concluded that it was too closely related to technology that could ultimately have military applications. The C.I.I.C. was disturbed to learn, in the course of its inquiry, that the 15 Taiwan engineers then at M.I.T. came from a laboratory dealing predominantly in military research. The committee in May recommended to President Jerome B. Wiesner that the focus be changed or that the program be terminated.

Campus protestors made the same demands throughout last spring. They feared that the engineers, after learning the principles of inertial navigation at M.I.T., would return to Taiwan to build inertial guidance systems for ballistic missiles to be used against the People's Republic of China on the mainland.

The problem had already surfaced once before, during the organization of the program. Under the original plan, the "hands-on" laboratory proj-

ect was to have been carried out under a subcontract from M.I.T. to the Charles S. Draper Laboratory, once a part of M.I.T. but now an independent, nonprofit entity renowned for its design and development of inertial navigation and inertial guidance systems, both civilian and military. Draper planned to use a N.A.S.A.-owned computer, and when N.A.S.A. received Draper's request for use of the computer the question was raised with the Munitions Control Office at the Department of State.

The Department of State asked Draper to withdraw, and the "hands-on" project was re-established in a laboratory at M.I.T. — on the same subject, but reduced in size, scope, and sophistication. It was this reduced project which the State Department asked to have eliminated late in the spring. — *J.M.*

Six Weeks on Board the *Kruzenshtern*: 10,000 Feet of Film and A New Russian "Family"

"Now I wake up mumbling *dobroye utrah* ('good morning' in Russian)," says Steve Ascher. He has reasons.

For most Americans, the Bicentennial event called Operation Sail (a flotilla of about 100 ships of many nations on a transatlantic race to the United States) was a one-day spectacle. For Steve Ascher and Pam Wise, their six-week voyage on board one of the ships was an incredible last-minute adventure. Mr. Ascher is a staff member of the M.I.T. film section in the Department of Architecture, where Ms. Wise does free-lance work.

Mr. Ascher became intrigued when a friend mentioned his scheduled trip on an American tall ship. He decided to attempt the trip, too — not as a sailor but as a documentary filmmaker. But he would need financial backing — and every lead ended in rejection. Even his desperate offer to pay his own way met with a "no room."

With two days left before departure, one unexpected opportunity materialized. Robert Drew Associates, a film company in New York, wanted a film crew to travel on board the huge Russian ship, *Kruzenshtern,* the largest sailing ship in the world. The resulting film would be used as part of a television documentary on Operation Sail.

A surprised Pam Wise was enlisted as a sound technician two days before Ascher was to leave. "I thought Steve was kidding, but I said, 'Sure.' When he said I'd have to pay my own way to the Canary Islands, I knew he was serious."

After a briefing from Drew in New York and a hurried gathering of equipment, they caught the next plane for Madrid and then to Tenerife, Canary Islands, where the ships were docked. Spanish and Russian grammar books were their only guides, their only introduction a letter from the Soviet Embassy in the United States and some translated correspondence between Mr. Drew and the Russian embassy.

"I had a dream that all the ships would be sparkling white in the sun — and the Russian ship would be a huge black thing under a dark ominous cloud," recalls Ms. Wise. "We got there and a gigantic black ship awaited us . . ."

Ushered on board, they faced a stern captain. Holding the letter of introduction in his hand, Capt. Ivan G. Schneider cross-examined them in fluent English: "You are a man and a woman; I expected two men. Are you married?" "No," the anxious reply.

After more questions, the captain's mood suddenly changed. He hugged Steve. "Welcome. You may both come. You will be on our ship." Accommodations were found (Steve shared a cabin with the equipment; Pam with a female doctor and a nurse.) But there was one caution: "We will be tired of you in five weeks — maybe you get off in Bermuda."

Top, this page: Steve Ascher, center, with shipmates; above: Pam Wise dancing with members of a cadet rock band on deck; opposite page: the *Kruzenshtern*, the largest sailing ship in the world. (Photos: Steve Ascher)

So began a voyage of 2,800 miles from the Canary Islands through Bermuda to Newport and New York as the only non-Russians with a crew of 240 Soviet cadets and officers.

"At first, things seemed very mysterious, threatening; there would be a knock on the door and I would be told to go to the captain's cabin. . . . On the bridge, he was aloof, businesslike. But in his cabin, he was a clown. His summons was soon welcomed rather than feared," says Mr. Ascher.

Ms. Wise remembers one peculiar incident: "We were becalmed in the Sargasso Sea. The captain came on the intercom and talked for 20 minutes while my bunkmates looked increasingly concerned. I recognized only two words: America and catastrophe. What if something terrible happened between the two countries — and here I am. . . . When it was over I anxiously asked the doctor, Ludmilla, what it was about. Her hands traced a triangle in the air; 'Bermude' she said — and I laughed with relief." (The crew was only being told the story of the mysterious Bermuda Triangle, the reputed site of countless disasters.)

As the ship neared Bermuda, the captain gave Ms. Wise a bouquet of Sargasso seaweed in wrapping paper tied with a velvet ribbon. His attached calling card said "to the Miss America — this bunch of ocean flowers with my compliments." She memorized a flowery thank you in Russian.

Mr. Ascher describes shipmates on the *Kruzenshtern* as "friendly, demonstrative, patient with my halting Russian. They are a loving people.

"When I began talking to one person, crowds would gather to join in. They were very interested in American music — so we would listen to pop tunes on the radio. I would write down the words for them, and then they could translate."

Ms. Wise remembers: "I never heard anything negative about America; when we pased the yachts in Newport, they just said how beautiful it was. The questions they asked were about geography, history, how much money we made, what things cost (especially blue jeans), athletic teams. Never about Watergate or blacks. And many had studied English . . . Imagine Americans asking about Russian athletic teams. (When we started to speak Russian, they'd laugh.) They seemed proud of their country.

"It was as if there was no difference in ideology; as if we were the same but had never had a chance to meet before.

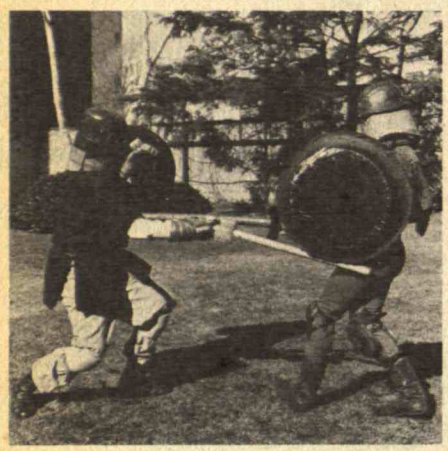
"I felt a different attitude toward women," she adds. "I could wear my little white bikini and they talked to me as if I were fully dressed. There were only ten women on board. But if the men were sitting together talking and I appeared, they would shove over, make a space for me and keep talking."

The two Americans landed in New York with 10,000 feet of film and many Russian friends. "At the end of our trip, we traded gifts," said Mr. Ascher. "I was given a beautiful collection of stamps; everyone signed it. I bought champagne and we toasted the Bicentennial.

"I had learned various Russian goodbys in preparation for leaving. But when it was time, I felt I was losing a huge family. Speaking at all was impossible." — *M.L.*

КРУЗЕНШТЕРН

"Ah, how I remember those long, lazy, balmy afternoons at the Institute. Sitting in the Great Court with a friend and soaking up the Boston sun. Not a worry in the world, not a care on my mind. After four years here, I savor the memory of every one of those days. Both of them."



Students

"Pictures Everyone Can Identify With"

"Everything else (at M.I.T.) is secondary to the people," says Paul L. Hertz, '77, Editor of *Technique '76*, M.I.T.'s yearbook published at the end of the summer.

That's why Mr. Hertz's book is full of pictures of people. And that's why Mark H. James, '78, likes it. "The book succeeds by the simple tactic of placing people first," writes Mr. James in an enthusiastic review in *The Tech.*

"The 'people' photographs are among the best in the book, (showing) interaction between photographer and subject. . . . The staff, instead of trying to prove their superiority to the rest of the world with lofty photographic statements, seem intent on providing a book everyone can identify with. . . . This is photography used in one of the best ways possible."

For some samples, see the pictures on these pages; for more, order a *Technique '76* ($12 from Technique, Room W20-457, M.I.T.).

Computers Take Over at *The Tech*, but Green-Eye-Shades and Cigars are Still in Style

Following the lead of newspapers and magazines (including *Technology Review*) all over the country, *The Tech* entered the computer age on April 9, producing its first issue on its own computerized phototypesetting equipment.

For seven years, *The Tech* owned and operated a collection of computer-driven I.B.M. typewriters whose product has included the paper's twice-weekly editions as well as countless typesetting jobs for M.I.T. offices and activities. Despite a deserved reputation for low prices, *The Tech's* profits on typesetting contracts and jobs have made possible free copies of the paper to the entire Institute community.

Now those seven years of pushing an incipient technology almost beyond its natural limits by breadboarding, tinkering, and fiddling have been parlayed into a $42,000 Dymo Pacesetter photocomposing machine and some peripherals — including a modern editing terminal. John Hanzel, '76, who was Chairman of *The Tech* when the purchase decision was made, says the new equipment will increase productivity and give *The Tech* a crack at "more and bigger typesetting jobs for the community. We figure it will pay for itself in just a few years through savings and increased speed," he says.

Suddenly this spring, *The Tech's* student operators stopped complaining that the "smudgeless" carbon ribbons were staining their hands, no one was asking how to hyphenate "faculty," and no one was splicing the fragile magnetic tapes on which copy was stored. After a day with crowds of curious people mobbing the production shop — some of them had been actually invited to a champagne christening party — the new machines settled down to a humming routine.

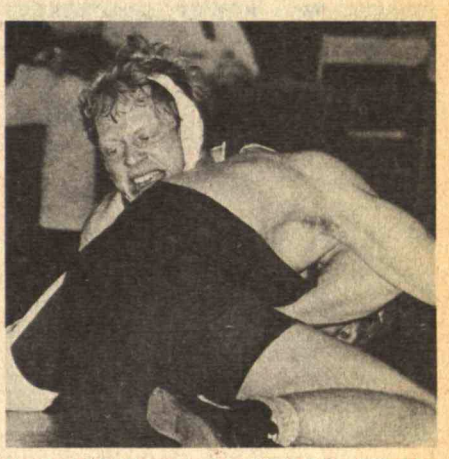
The Pacesetter was the major part of the purchase: a phototypesetter with eight type faces in 12 sizes and a good sized "dictionary" of hyphenation rules and exceptions, capable of setting 50 lines a minute.

But for *The Tech's* visitors, the Video-Display Editing Terminal (V.D.T.) was the irresistable toy — "especially when programmed to erase every third word and change all 's's to 't's in a Glenn Brownstein column," wrote Mark J. Munkacsy, '78, and Michael D. McNamee, '76, describing the scene at the christening party.

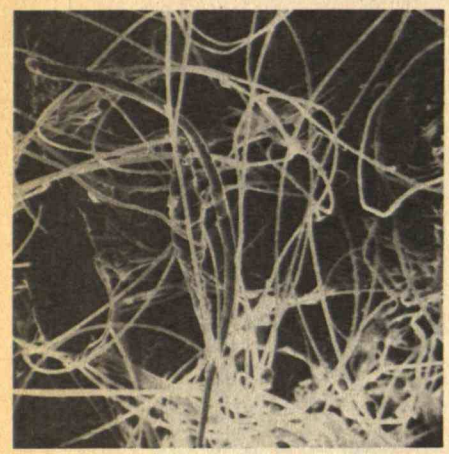
"A V.D.T. is simply a display tube and memory connected to a keyboard and some computer logic," they wrote. "Copy — articles, charts, tables, etc. — is typed at a paper type-punch which encodes the letters as holes in paper tape. The tape is fed into the V.D.T., and the copy appears on the screen, where it can be manipulated and edited by an operator at the keyboard.

"But all the paper's problems aren't solved by the chips and wiring of the new equipment. The type may be sharper and more legible, but the words that are typeset still have to be provided by people. And although the V.D.T. is called an 'editor,' it can no more spell correctly and fix grammar than it can wear a green eyeshade and smoke smelly cigars.

"And the curious crowds cluttering the shop on inauguration day found, to the editor's chagrin, the perils of the modern age as copy came rolling out of the Pacesetter's developer: the computer had hyphenated 'springs' as 'spr-ings.' "



Technique '76 is a people-oriented photographic chronicle of what its Editor says was "an ordinary year" at M.I.T. There are more pictures than words in this 272-page book — Volume 92 in *Technique's* annual series. A sampling of the pictures — and the words — is shown on this and the opposite page. (Photos: Dan Gauger, '79; Gary Pollard, '76; Robert Brewster, '78; Chun Lim Lau, '76; Carl Mann, '77; courtesy of *Technique*.)



Top: A six-story high, 30-foot-wide web was hung in the courtyard of M.I.T.'s Burton House last spring by Elliot Lach, '77, and two other students. Mr. Lach's electron micrograph of a spider web (bottom) enlarges it 360 times.

The Itsy, Bitsy Spider . . .

Spider webs have always fascinated Elliot Lach, an M.I.T. senior from Brookline. And his interest spans two extremes of size. Last spring, he worked on a six-story-high, 30-foot-wide web which was hung in the courtyard of M.I.T.'s Burton House (*see left*). The project was designed and executed by Mr. Lach and two other students in "Art and the Environment," taught by Professor Otto Peine, Director of the Center for Advanced Visual Studies.

Equally impressive are Mr. Lach's electron micrographs of spider webs. The second photograph shows a web sample enlarged 360 times; it emphasizes the variety of types and thicknesses of silk found in the web. The micrograph was made as part of Mr. Lach's use of spiders for sensory research — an investigation of the body and leg hair which act as sense organs both in spinning webs and capturing prey. After a year's work under U.R.O.P. (Undergraduate Research Oportunities Program), Mr. Lach writes in *Tech Engineering News* that the use of spiders as experimental animals in sensory research is "very promising." — *Melissa M. Weiksnar, '76*

Out of the Library, Into the Streets

Charges of political apathy among this generation of college students have been made ad infinitum. But perhaps students are as active as ever in the cause of social change, turning their energies to the dirtier, less visible work at hand.

So suggest a group of M.I.T. freshmen — members of Delta Tau Delta — who chose as their fraternity project participation in "Just-a-Start," a volunteer work program of the Cambridge Redevelopment Authority.

Armed with brooms, scrapers, and cans of spackle, the 11 freshmen reported to the basement community room of St. Anthony's Catholic Church one Saturday last winter. "We had to scrub down all the walls, scrape the ceilings, spackle, sand, and prime. That's as far as we got," reports Peter Griffith, '79, Freshman Class President for his fraternity. "The basement hadn't been touched in years," said Mr. Griffith. "It was hard work, but fun."

Now "Just-a-Start" is catching on. Three more M.I.T. fraternities — Phi Delta Theta, Beta Theta Pi, and Delta Epsilon — have pledged their energy and muscle to the program.

Two other fraternities — Phi Delta Theta and Beta Theta Pi — have since joined the bandwagon, and a total of 438 work hours has been logged.

Peter Sleeper, Program Manager of "Just-a-Start," was impressed by the number of volunteers — more than 50. "If other area universities were half as grass-rooted as M.I.T., it would be terribly helpful to community relations and the people who coordinate local self-help programs," he remarked.

"Just-a-Start" is supported in part by the M.I.T. Community Service Fund.

Mark Suchon, President of Delta Epsilon and a senior in Mechanical Engineering, said he hoped more community groups would call the fraternities for help. "We welcome ideas for projects, but right now we have to go out soliciting our own work. We want to get out the message that we're available and willing to do our part in the community."

Intramural Sports Are for Everyone, and Even the Coeds Play Football

"Better than doing problem sets," and almost as popular?

One way to describe intramural athletics at M.I.T. — unrivaled in scope, with 20 different sports, and unsurpassed in size (5,000 participants in a year) at any New England university and perhaps at any in the U.S.

The most popular sports are the "big three" — softball, football, and basketball — followed by volleyball and hockey, in that order. Last spring there were 100 teams and over 1,300 players in the softball program, and this year basketball entries are up by almost 30 to 139.

Professor David Michael, who is listed as Intramural Superviser as well as Swimming Program Director in the Department of Athletics, gives full credit to the students. "They make administrative decisions, organize the leagues, and referee the games," he told William Lasser, '78, of *The Tech*; Professor Michael's job is mostly to stand around and watch, he insisted.

Two or more leagues are arranged for each sport, the style of play in each being determined by the players' abilities and attitudes. Competition is fiercest in the A leagues; the C and D leagues are for those "more interested in playing than winning," is the way Mr. Lasser puts it. Those are the most popular leagues, too: of this year's 139 basketball teams, 75 are in C and D.

Women are nearly as much in the thick of it as men; indeed, this year McCormick Hall (the women's dormitory) fielded a football team in D league. "We didn't expect to win," one of its members told Mr. Lasser (and they didn't, he adds), "but we really wanted to meet people and have a good time."

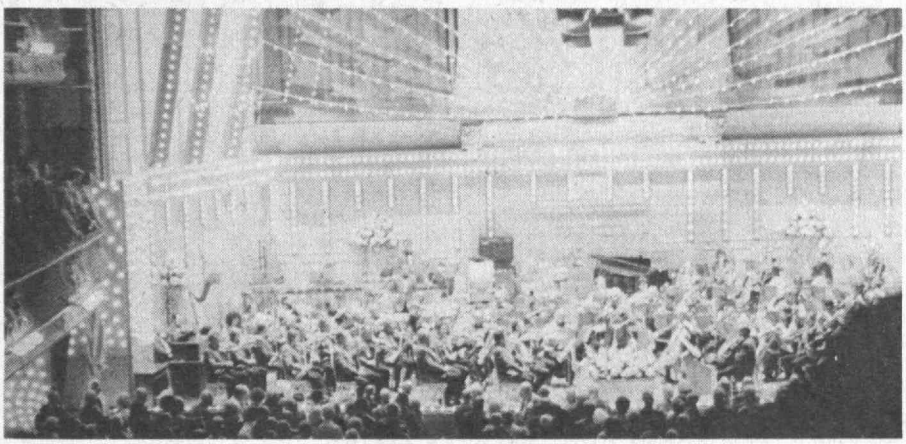
Tight Money and Tight Courts

But growing success has bred growing problems for intramurals, says Mr. Lasser. Both funds and facilities are short.

Student referees and umpires are paid from $2.25 to $4.00 an hour, depending on experience, and in three years the bill for referees has gone from less than $4,000 to over $10,000.

The pressure for space is high, too; fields, courts, and other facilities are in constant demand, and the rising popularity of hockey has given the skating rink an especially tight schedule.

Classes



A touch of Bicentennial Boston was added to the familiar Alumni Day festivities — Tech Night at the Pops, clambakes and sculling on the Charles — as Tony Hittl, Class President of '36, presents the 1936 Gift escorted by two members of the local minutemen. (left center photo: Darrell J. King, '72)

John Nolan, '03, and John Scoville, '11 at Alumni Day. (photos: Darrell J. King, '72)

99

The 101st anniversary of the City of Orlando, Fla., was celebrated on August 4. A museum housing a valuable collection of foreign and native antiques was dedicated at that time.

Your Acting Secretary and his wife, Minnette, being antique ourselves, were invited to cut the ribbon for the dedication. It was a special day for everyone with a parade of antique cars, a fair and street dancing. Music was by the Navy Band. — **Norman E. Seavey**, Acting Secretary, 1115 Westminster Towers, Orlando, Fla. 32801

01

Edward H. Davis, whose interest in and loyalty to M.I.T. were unbounded throughout the 75 years since his graduation in the Course in General Science and Engineering (IX), died on June 5 at the age of 97. He was associated for most of his working years with Scovill Manufacturing Co., Waterbury, Conn., where he served as Assistant Comptroller and statistician in the Research Department. He was also "curator of the company's vast button collection," wrote the *Waterbury American;* "he could identify every button made by Scovill by name and year of manufacture," and only recently was Mr. Davis forced to give up his habit of making a weekly visit to the Scovill archives which he organized.

Mr. Davis "impressed people with his dignified appearance and his vast knowledge of many subjects," wrote the *Waterbury American*. . . . "He had a scholarly and analytical approach, delighting people involved in discussion or debate with him. By outliving most of his contemporaries, he made an impression on four generations of Waterburians." — *J.M.*

03

At our recent alumni exercises your secretary was present to receive a standing ovation as the oldest alumni present!

As for another zealous active 1903 classmate, we proudly announced our Professor Emeritus of Electrical Engineering **Audrey A. Potter** as declared by his Alma Mater as "Deans of Deans" after 32 years at Purdue University. He presented 39,000 diplomas to his graduating classes who, incidently, love him. Many of his students are now top officials of utility, steel, paper, railroad and other important industries.

The obituary bell still tolls forth for the passing of our devoted classmate **George H. Garcelon**, 93 years old, on March 20,1975 at Longmeadow, Mass. He retired from Westinghouse in 1950 as Manager of Control and inventor of many small motors. He left three sons, (his wife died in 1974), seven grandchildren and three great-grandchildren.

Daniel A. Smith,of 29 Mary St., Newport, R.I., died June 22,1971.

Our Happy Birthdays this month for **Charles B. Cox**, November 4, 1881, 503 Orondo Ave., Wenatchee, Wash. 98801; **J. Russell Jones**, November 15, 1880, Highland Hills Dr., Halifax, Va. 24558; **Robert J. King**, November 29,1881, New Canaan, Conn. 06840; and **Jay B. Simon**, October 29,1879, 3300 Uticee Rd., Fraser, Mo. 48026. — **John J.A. Nolan**, Secretary-Treasurer, 13 Linden Ave., Somerville, Mass. 02143

04

William Perry Bentley of Dallas, Tex., died on April 6, 1976 at the age of 96. After receiving a graduate degree in electrical enginnering from M.I.T., Mr. Bentley founded and became president of Uvalde Construction Co. in Dallas. He served as chairman of the board until he retired ten years ago.

Mr. Bentley was a pioneer in the development of rock asphalt pavements and received an award for his contribution in 1940 from the Asphalt Technicians. He was a co-founder of the Foundation for Research on the Nature of Man; a member of the Technical Club of Dallas, the American Society for Psychical Research and the American Society of Civil Engineers. — **Eugene H. Russell, Jr.**, Secretary, 82 Stevens Rd., Needham, Mass. 02192

05

Mrs. Robert C. Bruce kindly sent in the following report on the death of her father: **Charles Benajah Mayer**, Course IV, passed away on February 15, 1976 in Sherman Oaks, Calif., at the age of 95.

Charles Benajah Mayer, '05

Charlie was born in Madison, Wis., on October 12, 1880. An architect and structural engineer, Charlie, for three years after graduation, was associated with the American Bridge Co. in New York City. In 1908, following his marriage to Josephine Agnes Baldwin, Charlie opened a branch office of the Trus-Kon Steel Co. in Indianapolis, Ind. After over 20 years as branch manager, he returned to New York City where he was affiliated in an engineering capacity with the city and state government. In 1947 he retired and re-located in his native Wisconsin until 1953 when he and Josephine moved to Los Angeles, Calif., where he resided until his death. In that same year 1953, Charlie lost his beloved wife, after 45 years of marriage.

While at M.I.T., Charlie was very active in musical circles, and distinguished himself as Leader of the Mandolin and Guitar Club. Also during his years at "Boston Tech," he won medals for his gymnastic ability. In later years he excelled as a tennis player and golfer, and he continued to bowl until age 80, winning many trophies and cups.

Charlie was blessed with wonderful health. He never had been confined to a hospital until after his 94th birthday, when it became necessary for him to have prostate surgery. He recovered completely from that operation, and was able to resume all of his prior activity, including driving his car, playing bridge, and thoroughly enjoying life. In 1975, a few days before his 95th birthday, he was stricken as he was in the process of renewing his driver's license. After a fainting spell he was rushed to a hospital where his ailment was finally diagnosed as a brain tumor. Again, he rallied, and was able to return home for three months. He was never bedridden or unable to go out until the last two weeks of his life.

Always devoted to M.I.T., he tried to attend every fifth-year reunion. He had planned to attend in 1975, but I think the death of his friend, the Class Secretary, Mr. **Fred Goldthwait** was a severe blow to Charlie and at the last minute, he decided against making the trip to Boston. He was an active Catholic, and a member of the Knights of Columbus, the Elks, and a Kiwanian for many years.

Charlie is survived by his three daughters, Mrs. Robert C. Bruce and Mrs. Betty Walther of Van Nuys, Calif., Mrs. George W. Gow of Wilton, Conn., and Hampton Bays, Long Island, seven grandchildren and eight great-grandchildren. — *S.F.*

07

Everett R. Cowen, Sr. of Louisville, Ky., died May 18, 1976. He was born in 1886 in New Bedford, Mass., where his father was a whaler. After graduating from M.I.T. in civil engineering, he began his lifelong career as a builder and estimator for Struck Construction Co. in Louisville in 1912. He retired in 1971 when he was 85.

Mr. Cowen was also past president of the Louisville chapter of Associated General Contractors. He is survived by his wife, the former Mary Sorenson; their sons, nine grandchildren and seven great-grandchildren. — *S.F.*

08

R. E. Drake writes: "We have sold our home in Brockton and are living full-time on Cape Cod. Had our 65th wedding anniversary in March."

We are sorry to report, somewhat belatedly, the

deaths of two classmates: **Arthur T. Hinckley** on August 11, 1975; and **Ferdinand J. Friedman** on September 26, 1975. Ferdinand's wife wrote from Montreal that he passed away after a long illness.

Karl Kennison has been admitted to the Newton-Wellesley Hospital in critical condition.

We have one change of address to report. **William Roy Heilman** has moved from his apartment to the Health Center of Westminster Village, Ind., 46142. — **Joseph W. Wattles III**, Secretary, 26 Bullard Rd., Weston, Mass. 02193

09

There were only two of us class members attending Alumni Day activities — president **Art Shaw** and secretary **Chet Dawes**. There were two ladies of the class, however — Muriel Dawes and Margaret (Mrs. **John F.**) **Davis**. It is regrettable that Betty Shaw, who for years never missed an alumni day or a reunion, was unable to attend. The Alumni Association has made it quite convenient to attend the Pops, Thursday evening, since buses provide transportation directly from the Institute to Symphony Hall and return. As an older class, our reserved table was in the front row adjacent to the stage. It was a real Tech night with the renowned Arthur Fiedler conducting and the program ending with "The Sons of M.I.T."

The Friday-morning session in Kresge was devoted to the Energy Revolution with David C. White, Director of the M.I.T. Energy Laboratory, as Moderator. In the latter part of the morning *Technology Review* held open house as usual with light refreshments for the class secretaries. At the luncheon in Rockwell Cage we were most pleasantly surprised when Elizabeth Clark Moroney, '54, came to our table and introduced herself as the daughter of the late **Horace Clark**, Course I, who played guard on the class football team along with your class secretary who played left end. Her husband, Dick Moroney, is a member of the class of '51. The luncheon was followed by the usual presentation of class gifts which are described in the July/August *Review*.

Earlier in these notes we told of being invited by Howard Johnson to a luncheon at the Historical Collections which exhibits artifacts and photographs relating to the development of the Institute. On Alumni Day there was frequent bus service to the collection which is growing steadily.

The Memorial Service for alumni reported deceased July, 1975 to May, 1976 was held at the beginning of the day's activities. Members of '09 listed were: **Denison K. Bullens**, **Joseph C. Dort**, **George H. Gray**, **Reginald W. Millard**, **Thomas C. Montgomery**, **Morse W. Rew**, and **W.M. Van Valkenburgh**. Most of these have already been reported in the class notes.

Our numbers have so decreased that we receive few news items. However, **Florence Luscomb**, our eminent coed, continues to receive prominent publicity in the news media. In the May 21 *Springfield* (Mass.) *Union*, there is an article with her picture entitled "Still Fighting Women's Battles." Her picture also covers the entire outside cover of the June 27 *New England* magazine of the *Boston Sunday Globe* and inside is an article, "Boston's Oldest Protester Still Going Strong at 89."

We recently received a note from **Harold W. Paine**, Course X, stating: "I was at Technology for two years following graduation from Brown and got an M.I.T. degree." He was an outstanding hockey player and captain of the M.I.T. hockey team. — **Chester L. Dawes**, Secretary, Pierce Hall, Harvard University, Cambridge, Mass. 02138

10

The following item is an excerpt from a letter from our class president, **Ralph Horne**, giving the highlights of his trip taken last May with his wife, Meta, their daughter and her husband: "Our trip was a short cruise on the Holland American *S.S. Rotterdam* to Nassau and Bermuda. During the trip Meta and I observed our 60th wedding anniversary and our daughter and her husband observed their 28th. Aboard ship before sailing, we were given a farewell send-off party with the customary champagne libation. One member of the party was my niece's husband who was the harbor pilot who guided the *S.S. Rotterdam* out of New York harbor.

"Our first stop was at Nassau, where we spent an evening at the Casino on Paradise Island and enjoyed a very elaborate and 'scantily-clad' floor show. The following day we enjoyed a sightseeing tour about the island of Nassau, which gave us an opportunity to observe many changes since our earlier visit on our 25th wedding anniversary.

"Although Meta and I usually retired about midnight while aboard ship, our daughter and her husband preferred to take in the available buffet, dancing, midnight shows, and other forms of entertainment. It was an enjoyable leisure-time cruise with generous meals served by a well-trained staff of Indonesian waiters. Living accommodations were most comfortable. The cruise left us craving some more, provided we are optimistic enough to think we could hold out physically."

Carl Lovejoy wrote in June that he and his wife, Glenna, were at their usual summer location at Black Mountain, N.C., near Asheville and the Blue Ridge Parkway. They expected to remain there until the fall. They plan to visit in Cleveland en route to their home at Boynton Beach, Fla.

Through an oversight, the name of our long-time class secretary, **Herbert S. Cleverdon**, who died on February 13, 1976, was not shown on the list of Deceased Alumni in the *Technology Review* until the July/August issue. However, your attention is called to the fact that his obituary was published in our class notes in the May issue.

During the past summer, **Art Curtis**, and his wife, Mary, took a 1,500-mile automobile trip, with friends to eastern Canada. They visited Art's old fishing territory, Blackville, on the Miramichi River in New Brunswick. During the summers, while he was a student at Tech, Art worked for an ice company. Not long after graduating, he purchased an ice business, and then a fuel company, first coal then oil. His business interests have expanded to include real estate and building materials. Currently his company is a distributor for equipment such as automatic stokers. Art still spends some time each day on these business activities and is not only a "Woman's Home Companion" (quoted from his letter). Art and Mary see the Horne's (Ralph and Meta) from time to time and often attend Technology Day activities together. In fact, they are sometimes the only 1910 representatives there (especially on those years in which our class is not celebrating a five-year reunion).

We regret to report the death of **John G. Ahlers** on May 2, 1976. In his last years he had retired from his consulting engineering (on the Columbia River Basin Project at Moses Lake, Washington) following an automobile accident. Fortunately, he was able to see many of his dreams come true for this area before his death. John was born on June 7, 1887. He prepared for M.I.T. at Trustrup Realskole in Denmark and attended Kansas State University for a short time before entering Tech. His activities at the Institute included the Cosmopolitan Club, Civil Engineering Society, staff member on *The Tech*, and president of the Technology Christian Association. The last reunion he attended was our 50th at Charterhouse Motor Hotel on Route 128 in Waltham. Some of his classmates at that reunion may recall that he was accompanied by a young son on that occasion. It is interesting to learn that this boy followed his father's profession (civil engineering) and in later years received the S.M. degree at Stanford (in construction engineering and management). We have been unable to get much information as to John's professional activities following graduation and prior to his major work at Moses Lake, Washington. However, it is recalled that at one time he was carried on our mailing list as Commander Ahlers. That leads us to believe that he may have served in the Civil Engineers Corps of the U.S. Navy — perhaps in connection with the "Seabees" during World War II. If more information is obtained as to his engineering activities prior to his work at Moses Lake, Washington, it will be included in the class notes in a subsequent issue of the *Technology Review*. — **John B. Babcock**, Secretary, 33 Richardson St., Portland, Maine 04103

11

Class President, **Howard Williams**, forwards the following update: "At the June commencement exercises the Class of 1911 held its 65th Reunion. We had hoped that a sizeable number of '11ers would be present on this occasion. However, circumstances prevented several classmates from attending as planned. Due to the illness of **'Chief' Wilson**'s wife, he was unable to be present. At the very last moment I had to cancel my plans to attend due to my wife's emergency eye surgery.

"And so there were only five members of 1911 in attendence. They were: **John H. Scoville** with his son and grandson, **Leroy Fitzherbert**, **Oswald Stewart** with his granddaughter, **Ralph Runels**, and **Charles F. Hobson**. What we lacked in numbers was more than made up for by the quality of those who attended. The appreciation of all in our Class goes to those who made this effort and represented us on this occasion.

"Since the death of our late Class Secretary, **Obie Clark**, there has been a scarcity of notes concerning our classmates. When picking up *Technology Review*, I turn first to the Class Notes in hopes that I may read something about my 1911 pals. It is always a disappointment when I find a 'blank' as is so often the case now. It would be my suggestion that each one — from time to time — write a few lines about his 'doings' and send them to Susanne Fairclough, Class Notes Editor, at the *Review*. In order to start this off, I have sent in the following:

"Having retired from active business eight years ago, and believing that the time had come to 'ease up' and give younger men a chance, I made a plan in order not to retire and 'go to seed' as I saw so many of my friends and compatriots doing. I decided to spend the balance of my life trying to help others and keeping myself busy and active each day.

"Having been in World War I in France, I knew what The Salvation Army had done for us 'over there.' I now sit on their Advisory Board and act as Chairman of the Advisory Council of the Evangeline Residence here in Los Angeles. Education and young people have interested me always. I have served on the Board — as well and Chairman of the Board of Trustees — of one of the Claremont Group of Colleges, and on the Advisory Board of The Los Angeles Art Center College of Design.

"In addition to these and other efforts, I breed and race thoroughbred horses. This business appears to be doing well this year despite the problems in such a business.

"When in business I never had time to become a good golfer. As a result my doctor started me on a program of walking each day. Even today I average about four miles in walking and attribute much of my good health to this fact.

"I wish for each of my classmates good health and much happiness throughout this year and those to come. I am sure that each one of us realizes the obligation we have to M.I.T. and will give to the best of our abilities to the Alumni Fund each year and make provisions in our wills for the Institute when our 'number comes up' — as we said in the Army. God Bless each one of you and your loved ones."

From Alumni Fund notes: **Paul A. Cushman** briefly states, "I am working seven days a week." . . . **George C. Kenney** writes: "My second pacemaker (good for seven more years) is working fine. I have already reserved one of them when this present job runs down." . . . **Sumner C. Willis** retired December 31, 1969 after 60 years with Stone and Webster, United Engineers, H.K. Ferguson and J.G. White. His main work in nationwide construction was with power plants and industrial projects. . . . **Minot Dennett** writes that he will be at the Belmont Hotel in Chicago till December 1, 1976 and then will return to Florida. He says, "Best regards to all classmates." — *S.F.*

12

I appreciate the honor of being elected Class Secretary. I realize that it is going to be very difficult to keep up with **Ray Wilson**'s record. How could I turn the job down when **Jon Noyes** solemnly told me it would be a lot of fun and that Ms. Fairclough in the *Review* office would do all the work?

A short note from **Harold Mitchell** states he "is returning to normal after a bout with pneumonia. Hope to see you in 1977." This should remind us all that our 65th will be coming up next year. Let's start thinking about it.

We have received news, somewhat belatedly, of the death of **Frank Caldwell** on December 24, 1974. While at M.I.T. Frank was interested in aeronautics. With a classmate, he designed and built a glider which they flew in a contest and won. Frank's thesis was on propellers and after graduation he became Chief of the Propeller Department at Curtis Aeroplane and Motor Co. at Buffalo. From 1917 to 1923 he was Chief of the Propeller Division of the Army Air Corps. In 1929 Frank joined the Standard Steel Propeller Co. which later became part of United Aircraft's Standard Division where he was named Corporate Director of Research in 1940, a post he held until retiring in 1955. While at Hamilton Standard he helped invent the controllable pitch propeller and was mentioned specifically in the Collier Award given Hamilton by the National Aeronautic Association.

With a shortage of news from the Class, it may be permissable for me to include a few notes from Julie and myself. We started off 1976 with a trip to Florida. Due to an ice storm we missed the AutoTrain and had to drive. This set us back several days and messed up all our reservations. Florida was jammed with visitors making it very difficult to get satisfactory accomodations, so we came home early.

In April, we flew to Las Vegas, looked in (only) on some of the casinos, rented a car and drove to Death Valley for a three-day stay; then to Ridgecrest, Calif., to visit a high-school classmate and on to Los Angeles and to San Diego where my sister and husband live, thence by plane to Indianapolis and home.

This summer we picked up **Jim Cook** at Marblehead and had lunch at Captains Courageous in Gloucester. Jim's various accidents have left him somewhat unsteady navigation-wise and he is quite hard of hearing — otherwise the same old Jim. In July **Harold Brackett** and niece Eleanor Forbes visited us at Squam Lake for a few days of fishing. After one very good session the fish just quit. — **Larry Cummings**, Secretary, R.R. 4, Connersville, Ind. 47331

13

We regret that we could not participate in the 1976 Alumni celebration. The Class was well represented at the Alumni Day luncheon, as reported by **Henry Glidden**, and we quote: "Another M.I.T. Alumni Day has come and gone. The class of 1913 was represented by eight **Francis Achard**, **Walter Muther** and his daughter, Sally Lawton, **Charlotte Sage** and guest, Grace Farrell ('29); **Warren Glancy**; my wife Jane and me. We wished you could have been with us. Gifts to M.I.T. from many sources were announced: for instance, this year's 25-year class gave an accumulated total of $1,951,311.00! We are in a new era! A fantastic total even though there were nearly 500 members to share it. However, M.I.T. is growing and its needs continually increase."

Henry also reports: "In May, Jane and I enjoyed eight days of perfect weather in Hamilton, Bermuda, at the Bermudians Hotel, the center of all sorts of activites, many concerned with eating! One day we took a nostalgic ride in a horse-drawn carriage, thru beautiful residential sections where much of the planting was in bloom. Something to remember! From the fifth floor of the hotel the view over the harbor was an ever-changing pattern of sea and of boats. The very moderate pace of all activites made Hamilton a perfect place to relax."

Francis Achard writes: "Sorry you were unable to attend the reunion. It was brief but excellent. We enjoyed reminiscing. I cannot report on the Pop Concert because I had to miss it. I had been elected Chairman of the Boston Chapter of the Society for Technical Communications (S.T.C.) and was honor-bound to attend the awards dinner of the Chapter and to receive my gavel the evening of June 3. Prior to that, I spent nearly four weeks on another "Dry Run," visiting my son, my daughter, and my niece by marriage in Rockville, Md., Prospect Park, Penn., and Ocean City, N.J. and also attended a not-so-dry S.T.C. Convention in Washington."

A short note was received from **L.A. Hechinger**: "Going strong at 86 years of age. Retired from active work at 80." . . . **Charles Alfred Smith** writes: "88 years old, civil engineer, land surveyor, registered in California and Nevada. Two married sons, five grandchildren, eight great-grandchildren. Health O.K. after lengthy stay in hospital. Active in engineering when anybody will retain my services. Have a wonderful wife, Rose."

We have received notices from the Alumni Association announcing the deaths of several members of the Class of 1913. Such announcements sadden us and we pass on to you some of the details for your information: **Herbert B. Alvord** of Chevy Chase, Md., died on March 27, 1976. . . . **Ellis W. Hartford** of Palm Springs, Calif., died on February 18, 1976. . . . **Robert B. Nichols** of Binghamton, N.Y., died on January 24, 1976. . . . **Ernest Weller**, of Setauket, N.Y., died on June 4, 1976. Notes of sympathy are being sent to the families. — **George Philip Capen,** Secretary/Treasurer; Rosalind R. Capen, Assistant Secretary, Granite Point Rd., Biddeford, Maine 04005

14

The main event of our 62nd "Bicentennial" Reunion was the class dinner, on June 2, in a room by ourselves in McCormick Hall at the Institute. **Walter Eberhard**, **Alden Waitt**, **Harold Wilkins** and I were the only members of the class present; several others had expected to come but for various reasons could not. Harold's wife, Marian, '31, paid us the compliment of taking time out from her own reunion to be with us. We had also, as guests, Richard F. Wright, director of advertising at *Technology Review;* Jennifer Gordon, secretary of the class of 1975 and a graduate student at the Institute; and Darrell J. King, '72, who was taking pictures of the many alumni on hand for reunions. Our dinner was a very pleasant and informal affair, with no speeches. No one wanted any changes among the class officers, so we didn't need to have a business meeting. Alden made a special trip from San Antonio to be with us, and arranged for me to share a pleasant room in McCormick with him. Next afternoon he and I took a trip in Boston harbor in a sight-seeing boat. In the evening we had dinner at the Top of the Hub, on the 52nd floor of the Prudential Tower, which stands between Boylston St. and Huntington Ave., where the Boston and Albany train yard was in our student days. From there we went to Tech Night at the Pops. Alden started home after breakfast next morning. I stayed for the Alumni Luncheon, where I was quite content to be outranked by members of several classes senior to ours, including one of the class of 1903.

Word came in July of the death of **Albert J. Hoyt** on March 12, 1976. The class records show that he was with us in all four of our undergraduate years and received his bachelor's degree in Course II. He joined American Steel and Wire Co. in 1914, and worked first in Trenton, N.J., and later in Worcester. In 1940 he was transferred to that company's office in Cleveland, and became manager of operations there in 1948. Since 1941 he had lived in Shaker Heights, Ohio. In 1915 he married the former Laurieta Downing. They had a son, Edmund Donald. — **Charles H. Chatfield**, Secretary, 177 Steel Rd., West Hartford, Conn. 06119

15

There was a time when our Class Notes were several pages back. Now they are on the second page — too near the front. Time marches on, and we are getting older. But how these (old) Classmates do get around: **Mary Plummer Rice** will be in Russia this fall on Red Cross work and will check for the few M.I.T. alumni registered there. She wrote that she heard all the big bridges in Russia have been built by M.I.T. men. How's that for Course I?. . . . "I'll do my best to contact all the M.I.T. men in Russia," she says. "I'll be alone, so maybe I'll be curtailed in the roaming around Moscow and Leningrad I hope to do. I'm going to see Red Cross or equivalent activities — psychiatric hospitals — and contact some University women as they are not permitted to join our International group. I wonder whether I'll be successful in any of my goals."

A card from **Phil Alger** in Zurich showed he was busy at that big I.E.E.E. Electro '76 Convention which he and his grandson, Monty Algers, '78, were attending. . . . **Bob Welles** planned to see the Tall Ships on a trip from California, but I didn't hear from him. . . . **Dinger Doane** was visiting family in Oakland, Calif. . . . **Alton Cook** wrote that he was glad to be at our 60th last June. He said he counted 12 of us "oldies" and a sprinkling of youngsters, which was good to see.

Supplementing the sad news last month on the death of his wife, **Evers Burtner** wrote: "Mary, as I mentioned, was a great help to me and in service to the graduating class of Course XIII, then Naval Architecture and Marine Engineering, now Ocean Engineering. For many many years she invited the boys and their wives to a Sunday evening smorgasbord or the equivalent. We had a sing and general good fellowship time. Groups like the Turkish and Chinese lads usually repaid this by hosting us."

Charlie Calder is very sick in a nursing home in West Barnet, Vt. His guardian wrote: "Nearly eight years ago he had a massive stroke, one side paralyzed. He recovered enough to use a cane and continued so until last July, when he had one or two strokes making him a bed patient and unable to walk or talk. I know he would want to be remembered to you all." . . . **Viking Enebuske** wrote from a nursing home in Lexington, Mass., about his early education in Europe.

Ellis Ellicott made a generous contribution to permanent funds of the Institute. . . . One of the Boston papers gave **Larry Landers** a splendid writeup after the big testimonial dinner given him in Boston on May 5 by Technion — the Israel Institute of Technology — for his role as founder of the Greater Boston Chapter of the Technion Society. "Brandeis University and his alma mater, the Massachusetts Institute of Technology have felt his impact," the writeup said. "He has established a scholarship fund at the Technion in memory of his late wife, Fanny Landers." A few of the many other groups Larry has made contributions to are the American Jewish Committee and the Combined Jewish Philanthropies of Greater Boston. . . . **Joe Livermore** wrote from a nursing home that he was sorry to miss our our 60th Reunion here last June. We missed Joe, too. . . . **Fritz Staub**, who was at our 60th, is having a book of his architectural work published. From Houston, Texas he wrote: "The author of the book is a very big architect and teacher. With little time for writing he is making slow progress — he insists upon designing the entire book and is having an assistant make a complete 'dummy' of every page — arranging text and photographs. He is an excellent writer and the book will no doubt be done well if it is ever finished — I fear it will be 1977 before it is ready for the publishers."

Ray Walcott is in the Ashbrook Nursing Home, 1610 Rasitan Rd., Scotch Plains, N.J. 07076. How about writing him a cheering note. . . . I'm ashamed not to have told you before that Alden Waitt, '14, made a generous contribution to the Alumni Fund in memory of **Seward Highley**, who died recently. Alden wrote: "We went to grade school and high school in Medford, Mass., and had been close friends ever since. We had

planned to visit together on Cape Cod this summer. Seward was the last of the group of boys I grew up with. Leicester Hamilton and Harold Richmond were some of our 1914 crowd. I read your 1915 Class Notes regularly and am glad to hear about **Jerry Coldwell**, **Ken Johnson**, **Jim Tobey**, **Archie Morrison** and **Jack Dalton**."

Here endeth the column for this month, with the sincere hope that you and your families have all enjoyed a pleasant and happy summer. — **Azel W. Mack**, Secretary, 100 Memorial Dr., Cambridge, Mass. 02142

16

We had a great reunion. Below you will see a picture of the group at Chatham Bars Inn for our 60th. We had reasonable Cape weather — rain on Tuesday but sunny, pleasant weather on Wednesday and Thursday. Everybody who attended was in good health and good humor. Again, we had several last-minute cancellations: Millie and **Charlie Reed**, Betty and **Charlie McCarthy**, Mary and **Ed Parsons**, Sylvia and **Vert Young** — all for health reasons, and Dorothy and **Dave Patten** who were expected but didn't make it. Hope and **Theron Curtis** and their two sons and respective wives called on Wednesday morning to say they couldn't make it. We later had letters from **Jack Camp** and Virginia and **Joel Connolly** telling us of complications which necessitated changes in their attendance plans. This is to be expected and is a disappointment to those of us who do attend as well as to those who had been looking forward to attending and had to cancel. Fortunately our information at the time was that in each instance the health needs were under control and in good hands. While at the reunion we were pleased to receive calls or letters of best wishes from **Francis Stern**, **Charlie Reed**, Jessie Brophy, and Mary Barker. At M.I.T. on Thursday night a member of the Class of 1926 brought us greetings from Anne and **Izzy Richmond**, with whom he had talked in a local supermarket that day.

We continue to see a great deal of enthusiasm for continuing our reunions on an annual basis, and taking one year at a time we will schedule them so long as there are people who are able and anxious to come. In January, 1977, we will send out a questionnaire and the response will determine whether we go back to Chatham or eliminate the ride to and from the Cape and stay in Cambridge or Boston.

Among the items covered at the Class meeting were: continuation of the present officers, keeping the reunions going and if possible at Chatham, and forming an organization to be known as "The Loyal Wives of the Class of 1916" to give long-overdue recognition to what our wives have done for our Class. We also had our Class "bull session" which focused on many topics: the trend at M.I.T. of becoming more and more a graduate school . . . the substantial increase in female enrollment . . . the increasing enrollment of students in medical, biology, and public health fields and the cooperative program with Harvard whereby the students become trained as medical doctors as well as in science and engineering . . . the special emphasis on energy and related matters . . . the substantial attention being given to world food shortages . . . the attention and study of our mass transportation needs . . . the current $225-million five-year fund-raising effort and the encouraging progress to date — $77 million already pledged or promised, with many members of our class helping in the fund-raising effort . . . the high esteem with which M.I.T. is held by many but also the lingering disenchantment of others who continue to be distressed by the disturbing events of the late 1960s and early 1970s at the Institute. New York City's financial difficulties and the city of Boston's shortage as well as the Panama Canal were also reviewed in this far-reaching session; spending policies, foreign policies and personal values and habits of our elected officials all came in for substantial knocks. It all happily ended with the conclusion that our country needs our continued support and involvement and the same is true for M.I.T.; where there is disagreement on Institute affairs, support could be in the form of financial aid as scholarships for worthy students who need help.

Late Wednesday **Paul Duff** took his wife Frances on an emergency dash from Chatham to their hospital in Danvers, and we were pleased to have the good news on Thursday morning that Frances was fine. They were disappointed to miss "Pops" on Thursday night because Paul and Arthur Fiedler were high school classmates. **Barney Gordon** pleased us again with his fine rendition of "Old Man River" as well as many of the songs from our Tech Shows of undergraduate years. All of us enjoyed a toast through the generosity of Mary Barker in tribute to the members of the Class of 1916, present and gone, for the many happy days that we enjoyed together.

Here are excerpts from some of the letters that we have received since the reunion: Frieda and **Hy Ullian**: "It was great to see all those that attended. Frieda and I are looking forward to next year's reunion." . . . Isabel and **Ralph Forsyth**: "You've done it again! Made two old folks very happy. We received the picture yesterday, and we were very pleased. Either that photographer is a marvelous artist or the Class of 1916 is a pretty chipper looking group." . . . Frances and **Paul Duff**: "We are both so happy that we were able to be with 'You all' for the 60th." . . . Marjorie and **Don Webster**: "Happy to see so many able to stand up and be counted. Sorry not to be able to do the Cambridge part of our reunion, but it looked a little too strenuous." . . . **George Crowell**: "Sorry we weren't able to stay longer, but we did have a fine time at the Clambake and it was good to visit with classmates I hadn't seen for many years." . . . Grace and **Dan Comiskey**: "Thanks for the pleasant 60th Reunion and the fine colored photo taken in Chatham. We both enjoyed ourselves meeting former classmates." . . . Hildegarde and **Jap Carr**: "It was a great reunion." . . . Mildred and **Frank Holmes**: "We enjoyed the reunion thoroughly. We have been spending most of the time since at our summer home in Fitzwilliam, N.H." We look forward to your cards and letters. Keep writing. — **Ralph A. Fletcher**, Acting Secretary, West Chelmsford, Mass. 01863

17

Technology (Alumni) Day was well attended — a record of 14 reunions on campus. Included were **Ray Brooks**, **Stan Lane**, **Al Lunn**, **Ray Stevens**, the **Ed Paynes** and the **Dunnings**. The new dinghy, with sail up, was prominently displayed at lunch. On it were numerals '17, '26, and '51; the classes that had made notable contributions to the Sailing Pavilion Campaign.

On October 2, the enlarged and modernized **Walter C. Wood** Sailing Pavilion, named in his honor, and the new fleet of sailboats will be dedicated. The original cost estimate was $212,000. After federal and state regulations were met, plus inflation, the cost soared to $280,000. George Warren Smith, '26, has done a phenomenal job in raising the money and is grateful to 1917 for its now completed contribution of nearly $30,000.

After 24 years the **Loengards** are selling their summer home in East Norwalk, Conn., and will reside now at their New York City address only. Dick advises that the Technology Club in Gramercy Square — a hangout for many '17ers years ago, and recently had existed in a dormant state — has been dissolved. Upon its demise over $5,000 was turned over to the Institute as a scholarship fund, the interest to aid students from New York. This has nothing to do with the present Alumni Center or the M.I.T. Luncheon Club which were descendants of the Technology Club.

Gatherings on the Cape this summer include: **Ray Brooks**, **Al Lunn** and **Tubby Strout**; the **Les Fords** entertained the **Ray Stevens**, the **Hunters**, **Dunhams** and **Dunnings**. The Dunnings had a

Classmates and their guests meet at the Chatham Bars Inn for the 60th Reunion of the Class of 1916. Standing left to right: Dan Comiskey, Bruce Crowell, Betty Crowell, Ralph Forsyth, Don Webster, Marjorie Webster, Doug Robertson, Walt Binger, Al Alberghini, John Fairfield, Sibyl Fletcher, Barney Gordon, Jap Carr, Earle Pearson, Stan Warshaw, Paul Duff, Nat Warshaw, Henry Shepard. Seated on chairs left to right: Isabel Forsyth, Grace Comiskey, Bettina Robertson, Beatrice Binger, Gladys Fairfield, Ralph Fletcher, Elizabeth Pattee, Hildegarde Carr, Frances Shepard, Charlie Lawrance, Frances Duff, Frank Holmes, Hank Smith. Seated on ground left to right: Rose O'Brien, Margaret Alberghini, Mildred Holmes, Lois Lawrance, Bob O'Brien. Also present but not pictured were Hy and Frieda Ullian.

pleasant visit later with Al Lunn and daughter Jean at Hyannis.

Ossie Holt is an avid lawn bowling enthusiast at Sunny Glen Bowling Greens at San Ramon, Calif. He also keeps his hand in as an expert candy maker. He plans to be present at our 60th next June. . . . **Leon Keach** at 83 doesn't find things too burdensome given good digestion and not too serious an outlook. . . . **Cy Medding** keeps active with his family, including 15 grandchildren and three great-grandchildren, most of whom live nearby in Virginia. . . . Our sympathy is extended to **Elmer Joslin** on the loss of his wife of 58 years. . . . **Luc Schoonmaker** has been in a nursing home in Gainsville, Fla., for the past three years. . . . **Al Kenigsberg** hopes to get to our 60th. Meanwhile he plugs away on several papers on cancer, dermatology and fundamental biology. . . . Congratulations to **Dick Lyons** on receiving an honary Doctor of Letters degree from the University of St. Thomas, Tex. Dick, "an independent oil operator and investor, was honored for his leadership in education, health care, and the petroleum industry."

With regret the deaths of three members are recorded: **Donald P. Daniels** of Los Angeles on January 22, 1975; **Leland C. Roberts** of Ithaca, N.Y., on May 13, 1976. **Irving Fineman** of Shaftsbury, Vt., died on March 31. He was an author and playwright and had served on the faculty of Bennington College. — **Stanley C. Dunning**, Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard**, Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

18

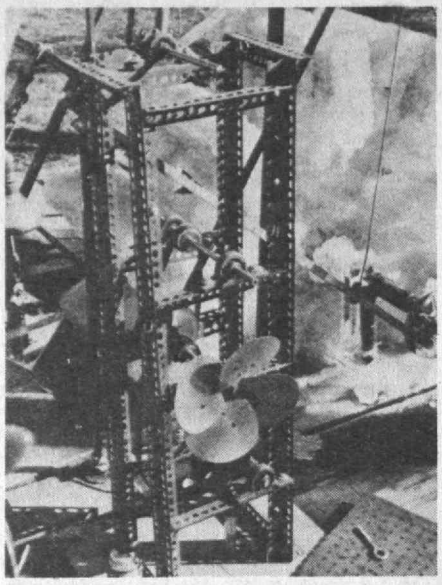
It is midsummer now — vacation time — and two months have passed since writing notes for the previous issue. I will therefore begin this report with early June, when the Class of 1918 was well represented by **Jim Bugbee**, **Julian Avery**, **Eli Berman**, **Len Levine**, Elizabeth and **Julie Howe**, Elinor and **John Kilduff**, **Nat Krass** and Miss Katz, and Selma and **Max Seltzer** at Technology Day (June 4).

We have been informed by the Historical Collections Director, Warren Seamans, that Narcissa **Chamberlain** has given **Sam**'s etching materials, camera, and related paraphernalia to the Department. It will shortly be arranged as an interesting exhibit. I recommend when you visit M.I.T. to take the time to see it — also the exhibit of telephones assembled by Carlton Tucker.

A letter from **Mal Baber**: "I have not been giving you much help recently, but truly life goes on in such an uneventful pattern that there is little of interest to write about. We recently attended my 60th at Yale. Of the 94 more or less alive members of the class, some 25 managed to get back. **Ed Little** and **Bill Wyer** wrote that health did not permit their attendance. It was a happy reunion — the usual euphoric nostalgia. I did notice that all returnees were able to bend the right elbow and did so with some regularity. I consider this confirmatory evidence of my theory that C_2H_5OH is indeed conducive to longevity."

Herb Hatch writes: "Things do not change much at our age. We stay around Wollaston from May until November, then follow the wild geese until we arrive at Zephyrhills, Fla., for the 'social season' with 15,000 retirees from all over the northern states and Ontario."

A short note from Bill Bassett, '19, who reports attending the Mayflower Congresses in Plymouth, Mass.; the General Council Meeting of the Society of Colonial Wars in Philadelphia; the New England Council of the Sons of the American Revolution in Keene, N.H.; and the annual meeting of the Massachusetts Society of the Cincinnati in Boston: "On May 7 my first great-grandson was born in Greenfield, Mass. My wife, Helen, and I have enjoyed our farm in New Hampshire for the past 16 years, where we moved after we left Scarsdale, N.Y. The apple orchard has given us fine apples since we arrived here and the ducks and geese have supplied us with plenty of eggs." . . . Faithful **John Abrams** is finishing his fight for water rights in Bishop, Calif. Among his other accomplishments unknown to me is that in the culinary field. I publish herewith a reprint from the publication *Ground Water Age* of March, 1976, entitled "What's Cooking?":



Perpetual motion machine designed by John Abrams, '18, using his water power.

"There aren't many better ways to start a long day that wrapping yourself around a batch of buttermilk pancakes, heaped with butter, drenched with maple syrup, and served with crisp bacon or sausage and steaming hot coffee:

1 pinch salt
1 pinch sugar
½ cup all-purpose flour
1 egg
1 teaspoon baking soda
1 cup buttermilk

"Mix salt and sugar in the flour. Beat one egg in a bowl. Mix baking soda in buttermilk and add to the egg. Add flour and beat well. Cook on a hot greased griddle.

"This makes seven hotcakes. Keep them small and eat them all."

Through the kindness of Elizabeth Doyle I learned of the death of her father, **Charles Warren Dow**. Following graduation Charles spent most of his life in the New England area in the leather business — the last 25 years as representative of the Diamond Shamrock Corp. He was a patron member of the Rockport Art Association, a deacon of the Lanesville Congregational Church, a member of the Chemical Club of New England, and active in Masonic affairs. He developed great skill as an amateur photographer as well as watercolor painter.

I also record with sadness the deaths of **Joseph Sattels** and **Joseph A. Kelley**. — **Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard Levine**, Assistant Secretary, 519 Washington St., Brookline, Mass. 02146

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Royden L. Burbank sent in a report of his attendance at the mini-reunion at Endicott House in Dedham in 1975. **Benjamin H. Bristol** was also present.

Edward G. Moody had a trip to England and Scotland and then to the Mardi Gras in New Orleans. Then he planned a trip to Nova Scotia and Prince Edward Island for three weeks in the fall, then to Virginia for Thanksgiving. He was been blessed with the arrival of a great-grandchild, a granddaughter, and the marriage of a grandson and in addition to the celebration of his 80th birthday. Congratulations.

Bob MacMullin received the Electrochemical Engineering and Technology award from the Electrochemical Society in Washington, D.C., on May 4 (silver medal and honorarium) and delivered a lecture. Bob says "for a retiree I am plenty busy. Regards."

Morton A. Smith recently visited Newport News, Va., and looked at the outside of a shipyard where about 30 of our class were employed after our sudden graduation in September, 1918. Morton says, "I still feel good and continue to do some radio service work to keep in practice after 54 years in the business."

News was received of the death of **William S. Burbank** of Exeter, N.H., on April 11, 1975, and of the passing of **Ralph C. Flewelling** of Pasadena, Calif., on December 30, 1975.

Arthur R. Ford writes from 212 Rodney Rd., Ridley Park, Penn. 19078, "I have had in mind to prepare a note for the *Review* and your card has caused me to do something about it. I am in fair shape, having been in the hospital two or three times of late, because of falls. I can get about on foot now but can no longer drive. I have no trouble keeping busy but cannot read very much because of declining use of my eyes. I am particularly interested in serious music and have tape recordings of music from the era of Bach to the near modern. I also spend some time writing and particularly regarding the evolution of road transport. My work for 25 years with the naval establishment at Johnsville, Penn., embraced a reasonably large variety of problems, relating to aircraft and missiles and placed me in a position to realize the necessity for forming broad views of matters."

Royden L. Burbank wrote in May: "About two months ago I had a 'blackout' which was not a heart attack or stroke and seemed to puzzle the doctors at the Massachusetts General Hospital. After an operation I have been home a month and a half and am very much better."

The Memorial Service for M.I.T. alumni deceased during the past year at the M.I.T. Chapel on June 4, 1976 included the following from our class: **Marshall C. Balfour**, **William H. Banks**, **Ray H. Bartlett**, **Wilbur S. Burbank**, **Alfred G. Hoffman**, **Alfred W. Hough**, **George A. Irwin** and **William R. MacKay**.

Our classmate **Bess Fichter** writes from Baltimore, Md., "I am actively retired from any work. As for my family, I have one daughter who is a graduate of the University of Pennsylvania and the University of Maryland School of Law. Her son is now finishing his third year at M.I.T."

A note from **E. Doten** reads, "So nice to have word from you. Not much to report from Detroit. I still have my part-time connection and go to the office every day. Iva's recent fall resulted in fractured ribs. So not planning any travel at the moment." . . . **H.W. "Denny" Denison** writes, "All is the same with me. I am blessed with good health but my wife is not well. Hope you are in your usual good spirits and that there will be more word from the class." . . . **Herbert L. Duffy**, 5955

18th St. N., Apt. 9, St. Petersburg, Fla. 33714 writes, "There is little I can tell about myself. I have had a very uneventful life. I joined the navy in 1917, retired as an ensign in 1921. Retired from Texaco refinery in 1960 in Laurenceville, Ill. Played a lot of golf until I quit in 1971. Been married three times, no children. Moved to Florida in 1964 and like it very much all the year around. I turned 80 last August (1975). Am bowling four afternoons a week. Best regards."

Edward Adams Richardson writes, "no change, had an interesting letter from **Ralph Cartwright** of our class who seems to be getting along famously." . . . **Richard S. Holmgren** says the year 1975 was a specially significant year for him. "I reached my 80th birthday and celebrated my golden wedding anniversary. We are still active travelers. Spent February, 1976 on a month's tour to southeast Asia, visiting Indonesia and Thailand. Bali was the high point." . . . **Louis J. Grayson** says, "We are still thoroughly enjoying our retirement, especially the freedom to travel at will, and the absence of pressure and tension. We recently returned from two months in Jekyll Island, Ga. There's always plenty to keep us occupied and interested in Washington where we still live within the District limits." . . . **Maurice Goodridge** writes from Worcester, Mass., "We have eight fine grandchildren. Eleanor and I still enjoy living at 37 Old English Rd., Worcester, Mass., with the changing seasons. My Parkinson's and arthritis slow me down but I eat three good meals a day and look forward to visits from friends and family. Two of our three girls live in Colorado with Professor Husbands at the School of Mines and Metro in Denver. We fly out to see them once a year or they come east to enjoy our camp at Great East Lake, Acton, Maine. We remember the 50th and 55th reunions at Chatham with pleasure and would like to hear from any who come this way. Telephone 756-2160."

Doc **Edmund J. Flynn** writes, "I am alive and well and busy trying to keep up with the needs of this place with its grass and gardens and wood lot, plus reduced but continuing activity for the annual Palmerton Hospital Festival. Jo Ann (17) and Charles (13) continue to pick up trophies now and then as competition skiers. Jo will enter the University of Vermont in September. Fly fishing for trout has started and I expect to get the sailboat on the lake in a couple of weeks. Best wishes." . . . **Ralph H. Gilbert** writes, "My new address is 4 Bellmore Ave., Pt. Lookout, N.Y. 11569. Just completed my third winter here and will now start my 41st summer. This is a delightful place to retire, combining city, country and seashore living."

Marshall Balfour's wife Peg wrote that they celebrated their 56th wedding anniversary March 5 and Marshall's accident was March 20. She writes, "The shock has been hard to get over. On May 26 we are taking Bal's ashes to Marlboro, Mass., to be buried beside his parents. Then I will see his 1926 Harvard Medical School classmates in Boston on their 50th anniversary."

The news report of **Alfred W. Hough**'s death on February 26, 1976 in Chatham states, "He was born in Oneonta, N.Y., graduated Braintree High School and M.I.T., 1919, with a B.S. in mechanical engineering. He joined the navy as ensign upon graduation. After two years with the Electric Boat Co. he joined the General Electric Co. in Pittsfield. He was made Superintendant of the district transformer division in September, 1933, Manager of Manufacturing Transformer and Allied Products Department in November, 1947, then General Manager of Capacitor Department in Hudson Falls, N.Y. — **E.R. Smoley**, Secretary, 50 East Rd., Apt. 11E, Delray Beach, Fla. 33444

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Rather a better turnout of classmates at Alumni Day in June than expected. Amy and I were happy to visit with Betty and **Norrie Abbott**, Betty and **Al Burke**, Mina and **Perk Bugbee**, Barbara and **Bill Dewey** and Ruth and **El Wason**, all with looks and spirits that belied their years. The Abbotts are off on their Alaskan tour in August. Expressing regrets at inability to be with us were **Bill Honiss** of Boca Raton, Fla., **Stan Reynolds** of New York City, and **Art Merriman** of Cleveland Heights, Ohio. Art had a long spell in the hospital but is now home and recuperating. **Bob Bradley** has had a long period of ill health and is presently confined to Dartmouth Nursing Home near his home in South Dartmouth, Mass. We hope for his complete recovery.

A welcome letter from Ruth **Margolis** tells why she and her late husband, **Joe**, were justifiably proud of their two daughters, both of whom live in New York. One is the wife of the chief of neurosurgery and director of St. Vincent's Hospital, and the other is wife of the dean of architecture at Columbia University. Ruth resides at Sea-Air Towers in Hollywood, Fla.

Clint Bond writes that after spending 30 years in India and Ceylon with Mobil Oil Corp., 20 years of which were shared by his wife, they have retired to the hills of Dover, Vt. Clint refers to the fact that he and I were on the tug-of-war freshman team 60 years ago and he believes that this "training" partially accounts for the fact that he has retained his excellent health. . . . **Chuck Lawson** of Naples, Fla., keeps exceedingly active. He is director of the Boulevard Club, a past director of the Naples Civic Association, a founding director of the Moorings Country Club. A retired Colonel of the U.S.A.F., Chuck continues to enjoy life, aided and abetted by his eight grandchildren and one great-grandchild. . . . **Dolly Gray**, of Sarasota, Fla., writes that he spends most of his time raising oranges and grapefruit after retiring from his real estate business and previously retiring from Alcoa. He spends the summer in Maine, has a daughter in London and a granddaughter in Texas. . . . **George Wilson** of Braintree, Mass., continues to actively pursue his several hobbies, according to a recent note.

One of the graduates of the class of '76 at M.I.T. is Herbert M. Federhen V, whose father is Col. Herbert M. Federhen IV, class of '49, and whose grandfather was **Herbert M. Federhen III**, a beloved deceased member of our own class. As the news release from M.I.T. states, "The year is different, but the name's the same."

Howard Williams of 14 Colby Rd., Braintree, Mass., died last June. Born in Kingston, Ontario, he graduated from Queens College and then attended M.I.T. with our class. For the last 50 years he was a partner of Fay, Spoffard, and Thorndike in Boston. He was a charter member of the Boston Society of Civil Engineers, a member of the Skating Club of Boston and the Kittansett Club in Marion. He leaves his wife, Margaret, two sons, and a daughter.

It gives me pleasure to report a June wedding. **Warren Chaffin** married Marion Sears and the couple will reside in Plymouth once their new house is ready. Mina and Perk Bugbee are looking forward to having such attractive neighbors. — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, Mass. 01890

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Wasn't it a grand reunion! Our 55th is now history. The reunion committee consisting of **Ed Dube**, **John Mattson**, **Don Morse** and **Mel Jenney** did a bang-up job and the class owes them many thanks for a good program, delicious meals, fine arrangements and a lot of hard work. Most of the group arrived on the afternoon of June 1 and including wives and those that came just for Technology Day, there were 57 of us. Coming without wives were **Wallace Adams**, **Harry Butters**, **George Chutter**, **Bob Miller**, **Henry Taintor**, **Alfred Wason**, '20, **Frank Whelan** and **Ralph Gilbert** '19. Attending with wives were **Elliott Adams**, **John Barriger**, **Dayton Brown**, **Carole Clarke**, **Phil Coffin**, **Ed Dube**, **Ben Fisher**, **Munroe Hawes**, **Sumner Hayward**, **Dugald Jackson**, **Irving Jakobson**, **Melvin Jenney**, **Chesterton Knight**, **Al Lloyd**, **John Mattson**, **Don Morse**, **Jim Parsons**, **Paul Rutherford**, **Edmund MacDonald**, **George Schnitzler**, **Ralph Shaw**, **George Welch**, **Whitney Wetherell**, and **Roy Wood**. Last but not least, we were delighted to have Helen (Mrs. **Raymond**) **St. Laurent** with us.

The gang assembled for cocktails and dinner that first night in the West Lounge of the Student Center. We were honored to have Mr. and Mrs. Howard Richardson as our guests for dinner. Howard, of course, was President of the Alumni Association this past year. A brief business meeting was held with Class President **Irving Jakobson** presiding. **Roy Wood** gave a treasurer's report which showed that the treasury was in fine shape with no need for dues. Income for the past five years exceeded expenses. A moment of silence was called for in remembrance of departed ones. Thanks were expressed to **Cac Clarke**, Secretary-Treasurer Emeritus, for 50 years of outstanding class notes and devoted service to the class. The Nominating Committee consisting of **Phil Coffin**, Chairman, **Josiah Crosby**, **Whittier Spaulding** and **Robert Miller** presented the following slate for a five year term: President, **Irving D. Jakobson**; Vice President and Treasurer, **A. Royal Wood**; Secretary, **Sumner Hayward**; 60th Reunion Chairman, **Donald G. Morse**. A vote for the slate was duly cast. Following the business meeting, **John Mattson** entertained with verse and song in which the class joined.

After breakfast the next day, buses outside McCormick Hall took the gang off on trip to the north shore through Swampscott, Lynn, Marblehead, Salem and Rockport. An interesting highlight was seeing the original of the painting "Spirit of '76" in the Marblehead Town Hall. We had an excellent picnic lunch at Salem Willows overlooking the harbor.

That evening we departed by bus to Framingham for a dinner-theater outing. The dinner was delicious (prime ribs), but the play "Bottoms Up — 1976" had to be rated "X." The reunion committee was shocked and at the end of the first act the class departed for McCormick Hall.

On our final day before Technology Day, the class took a boat trip around Boston Harbor followed by lunch at Joseph's Aquarium restaurant. Our afternoon excursion to the Skywalk with a 360° view of Boston and vicinity, plus the "Where's Boston" show at the Prudential Center, were fascinating. The latter was an excellent historic multi-screen slide show — a Bicentennial treat. Cocktails and dinner were at McCormick that night at which guests included General and Mrs. James Lampert (Vice President for Resource Development), Phyllis and Don Severance (Development Fund) and Anne and John Mattill (Editor, *Technology Review*). Also at dinner that night were Madeline and **Rufe Shaw**'s daughter Mary Shaw Carretta and Elizabeth and **John Barriger**'s granddaughter (third generation M.I.T.) Lann Salyard. Arthur Fiedler conducted the Boston Pops orchestra in his M.I.T. jacket that night and it was a wonderful conclusion to our three days.

Reunion Addenda

Our class Photohistorian **Bob Miller** assembled a new album of class pictures for the affair, which was on display at cocktails Thursday afternoon. This fine album was left to be part of the M.I.T. Historical Collections. The collection of old pictures and memorabilia is worth seeing and I urge any visiting classmate that hasn't seen it to ask for it.

A bolo tie with the M.I.T. beaver etched in brass was in our reunion packet upon arrival. Some extra ties are available and can be obtained at $4.50 each from **Don Morse**.

The reason that Mary Shaw Carretta appeared at dinner Thursday night was that she brought the shocking news of Madeline and **Rufe Shaw**'s house being vandalized and then set on fire after they left for our reunion. The house was gutted. Mary got word to the Alumni Association office and they jumped in to help and met Mary at the Boston airport. The Shaws left for Beverly, N.J., Friday morning with Mary driving.

Dayton Brown and his wife stayed only one night at reunion because Dayton had recently had a pacemaker installed and was still convalescing. So we now have a second classmate with a pacemaker, Jim Parsons being the other.

Henry Taintor made it to reunion all the way from California and stayed with his old friends Hazel and Whitney Wetherell on Cape Cod. I hear

they burned up the roads for a few days around the Cape.

Helen St. Laurent has since reported she left for her summer at Vinalhaven, Maine, in July and the mosquitoes are ravenous. The Red Cross in Manchester, Conn., presented Helen with a pin for more than 30 years of service. That's our Helen!

Letters of regret at not getting to our 55th came in from Assistant Secretary **Josh Crosby**, **Helier Rodriguez** of Tampa, Fla., and **Edward (Scripps) Booth** of Boca Raton, Fla. Josh left for their summer cottage in Brooklin, Maine, late in June and expected to stop a couple of days at Beth and Whit Spaulding's in Boothbay Harbor. Helier Rodriguez wrote that his reunion reservations were all made when they learned that Graciela's brother-in-law was facing surgery, so they felt they should remain nearby. We missed this fine couple. Scripps Booth wrote, "I had a busy tax season which I am sorry to state looks to be my last, due to rapidly failing vision. This problem is what kept me from coming to reunion in Cambridge." Scripps and his wife Helen celebrated their 50th wedding anniversary last October. Congratulations!

From Alumni Fund envelopes

Hilliard D. Cook of Raleigh, N.C., writes "I am pleased to note, by the *Review*, that a few of my old friends are still active." . . . A note from **James Entwistle** of Crawford, Maine, states that "both Mrs. E and myself are in excellent health. I have been retired since 1961. Keep busy as a registered Investment Adviser to eastern Maine executives and professionals." . . . **John Sherman** of Waltham, Mass., is still working part-time as curator of the museum at Masonic Temple in Boston. . . . **Roy Wehe** of San Mateo, Calif., reports that "Last fall we had a delightful foliage tour into Canada and the eastern coast and a Bicentennial tour of the New England states, New York, Pennsylvania, Maryland and Virginia. We drove by M.I.T." . . . Irene and **George Welch** of Poughkeepsie, N.Y., took a trip around the Caribbean in January and then spent February and part of March in Winter Haven, Fla. . . . **Frank Whelan** of Brighton, Mass., who attended our 55th, writes that he is now retired and can devote time to his hobbies.

The sympathy of the class is extended to the families of five classmates, whose deaths are hereby recorded: **Flemmon P. Hall**, Cherryville, N.C., on May 30, 1975; **Lester F. Rhodes**, Rohnert Park, Calif., on August 20, 1975; **Myer A. Weisman**, Los Angeles, Calif., in January, 1976; **Roy C. Mitchell**, Chapel Hill, N.C., on April 17, 1976; and **George A. Chutter**, East Denis, Mass., on July 19, 1976.

Dr. Hall got his bachelor's degree from Vanderbilt University in 1918 and earned both an M.S. and Ph.D at M.I.T. In 1941 he was president of the M.I.T. Club of Syracuse, N.Y. His career was spent in research at E. I. du Pont, National Bureau of Standards, Standard Oil Co. of N.Y., and finally at the Syracuse China Corp. from which he retired as Research Director in 1969.

Colonel Rhodes was District Engineer of the U.S. Corps of Engineers in Sacramento, Calif.

Roy Mitchell spent his business career with the Commercial Solvents Corp. in Terre Haute, Ind.

Myer Weisman worked as civil engineer in the water departments of New York City and Los Angeles from which he retired as Division Engineer.

George Chutter was past president of the M.I.T. Club of Northern New Jersey, Chairman of our 50th Reunion Committee, and a member of the Alumni Council. George worked for the General Electric Co.; the Wisconsin Public Service Commission and Hevi Duty Electric Co. For the last 18 years of his business career he was self-employed as a manufacturers' representative for industrial furnaces. We shall all miss him keenly. — **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden**, Assistant Secretary, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

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At least eight of the Class faithful from the Boston area attended Technology Day in June. We saw **Yardley Chittick** and **Buck Eacker**, who send regards to all. **Oscar Horovitz** was attending the program with Mary. **Marjorie Pierce** is still discussing architecture of small homes and **George Dandrow** the plaster to put on their walls (he attended with Catherine). We visited with **Ted Miller** of Prides Crossing and **Fearing Pratt** of Hingham. **Winthrop F. Potter** had lunch with us, coming in from Lexington. It was a good day and a most interesting program throughout. Your Secretary made copious notes, including a review of the lectures and visits to laboratories. Come to Buffalo and hear it all while we fill the little holes at the Cherry Hill Club.

Parke Appel has written about the loss of classmate **Dale Spoor** just three months following Katherine. They were a loyal couple who supported the Class constantly and performed great services as Class Agents. And we must again mention **Warren Ferguson**, whom we lost last winter, as our Class Treasurer. He was our first Class Agent who called himself "The Collector." Parke has been active in the M.I.T. Club in Southwest Florida and has seen **Bunt Spalding** and **Rudolph Blatter** of Sarasota, **Al Powell** of Bradenton, and many alumni from adjoining areas. He also heard from the Chitticks on their way to Sanabel and Captiva Islands, and he talked to **Ab Johnson** at his summer place in Michigan, who reports all is well.

Oscar and Mary Horovitz will be returning to Palm-Aire at Pompano in October after helping produce the historical film of M.I.T. for the Alumni Officers Conference in September. . . . **Norman J. Greene** of Newton Square, Penn., has been visiting in the White Mountains at the Spalding Inn Club and writes an enthusiastic report. . . . **Roscoe Sherbrooke** of Cohasset has forwarded an article telling of the death of **George A. Chutter**, who was partially '21 and '22. George was a retired electrical engineer from East Dennis and active in many organizations and societies. . . . **Wilfrid M. (Tommy) Thomson**, Corona Del Mar, hopes to spend some time in Florida this winter. . . . **C. Randolph (Randy) Myer, Jr.** of Wilton, N.H., is still playing tennis and skiing in preparation for seeing us up there next year. . . . **John M. Goodnow** of Greenbush, Mass. has retired in good health and is thankful for his many blessings. We hope to see him next year. . . . The same applies to **Philip M. Hastings** of Baltimore.

Jack and Ellen Long **Starkweather** celebrated their 50th wedding anniversary last March at the Holiday Inn near Venice, Fla. Some 70 friends attended with their sons, William from Amherst and David from Orinda, Calif. M.I.T. friends who were there included Parke and Madeline Appel and **Al** and Ethel **Smith** from Venice. The Starkweathers enjoy their summer cottage on Sunset Lake in Ashburnham, Mass., and return to Florida for the eight winter months.

We send the sympathy of our Class to the families of Lt. Col. **Walter H. Sitz** of Chevy Chase, Md.; **William B. Jones** of San Marino, Calif.; **Benjamin A. Dickson** of Devon, Penn.; **Otis C. Angier** of Clearwater, Fla.; and **Laurence R. Culver** of Satellite Beach, Fla. . . . The present plan for our 55th is to attend the Alumni Day in Cambridge (June 10) and then take a bus from Cambridge to Whitefield, N.H., for three days at the Spalding Inn Club — with bus returning, as well. Already **Chuck Brokaw** has told Parke Appel that he's coming.

Good luck and good health to all — **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

23

The great news this month is the announcement of the endowment of three new professorships by Mr. and Mrs. **Cecil H. Green** of Dallas, Texas. In addition to their many gifts and beneficences, Cecil and Ida have contributed a further sum of $3 million to establish the three new chairs — two in the Department of Earth and Planetary Sciences and the third in the Department of Physics. This brings a total of six professorships established by our good and loyal friends, Cecil and Ida Green. Also, we are again delighted to learn of the establishment by M.I.T. of the **David**

Members of the Class of '21 return from a cruise of the Boston harbor.

W. Skinner Professorship using trust funds provided by our good departed friend and classmate, Dave. President Wiesner said, "David Skinner spent the last 30 years of his life working diligently to advance education and research at M.I.T. It was natural for him to do so because of his deep loyalty and attachment to the Institute." In the July/August issue of this publication there was a brief mention of **Julius Stratton**'s 75th birthday.

We now learn of another highlight concerning this event. Apparently at the annual dinner of Friends of Switzerland held at the Busch Reisinger Museum of Harvard the guests sang out a rousing "Happy Birthday" to honor Julius. Highlight of the dinner was the presentation of the 10th Julius Stratton Award for Cultural Achievement to Dr. Alain B. Rossier, Chief of Spinal Cord Injury Services, Veterans Administration Hospital, West Roxbury, Mass.

And now for delectable tidbits from our classmates. **Harry Green** reports he is "keeping busy in my special field: trading in metals — copper, silver and gold." . . . **Atherton Hastings** of Florence, Ala., wrote: "I am working with the City Engineer on solid waste problems trying to improve the local ecology, you might say. . . . Between taking care of U.U. Fellowship, A.A.R.P., V.I.T.A., and solid waste, I keep busy." . . . **Harry Kalker** says, "After nine years of retirement . . . a trip around the world on the *S.S. France,* many cruises, and six months at winter resorts, I decided to retire into something. I formed a new company with my son as president and executive officer and am having an exciting experience developing products you will soon hear about." . . . From **Roger E. Phelps** of Oakford, Penn., we learn — "Dear Alumni Secretary: Regarding gifts, it has not been my fortune to accumulate wealth but rather to accumulate obligations. I do appreciate very much the five years I put in at M.I.T. following World War I and my army discharge." . . . And word from **William L. Searles**: "In the 15th year of retirement we are actively enjoying our 13th year of residence in Rancho Bernardo, San Diego, Calif., as are a number of M.I.T. Alumni." Great, Bill, we almost moved there! . . . From **D. G. Brinton Thompson**: "I am still in *Who's Who*!" . . . **Ida B. Webster** wrote: "I am a full-time architect. Have had great good fortune: never hunting jobs, received awards for our work. Like all architects we are hurting and filing endless forms for federal work." . . . From **Edwin D. Wilson**: "I would like to hear from anyone out of X-A '23."

And now for six sad items of necrology. From daughter of **Robert T. Colburn**, Mrs. Richard Norton, we learn of the death of "R.T." on May 21, 1976. After receiving his B.S. in Architectural Engineering he became associated with Nashville Bridge Co., Northeast Electric Co., and then with Stone and Webster as a structural designer. In 1933 he joined Tennessee Valley Authority as Assistant Construction Plant Engineer. Until his retirement in 1966 he was associated for 21 years with Chas. T. Main, Inc., of Boston achieving directorship in 1950, and vice president of C.T. Main International in 1962. He was active in many clubs, associations and professional societies.

Sydney W. Blackett passed away on June 3, 1976. He served in the U.S. Navy in World War I. He attended Wesleyan University before entering M.I.T. and graduated with us with B.S. in Mechanical Engineering. He successively held positions with the Atlantic Refining Co., New England Confectionary Co. and 28 years as plant engineer for Procter and Gamble, Staten Island, N.Y.

John Raymond Eiffe died on June 6, 1976. Born in Salem, Mass., in 1902 he graduated with us with a B.S. in Chemical Engineering and in 1924 received his M.S. in Chemical Engineering Practice. After graduation John joined the Standard Oil Co. of New Jersey and retired as general superintendent of Bayway Refinery at Linden, N.J. In World War II he served as liaison officer handling petroleum products in New York Harbor for overseas shipment. He was a director of Red Cross and other welfare organizations and active in civic affairs.

Hyman F. Marshall died on June 6, 1976. Born in Russia in 1903, he prepared for M.I.T. at Gloucester High School and received his B.S. degree with us in Chemical Engineering. He established the firm of Marshall Oil Co. of Quincy, Mass., serving as its president until retirement.

Lawrence J. Tracy passed away on March 18, 1976. Born in Cambridge he prepared at Cambridge High School and received his B.S. in Aeronautical Engineering with our class. Throughout his life he was associated with various Boston architectural firms including Stone and Webster; Cleverdon, Varney and Pike; Hoyle, Doran and Berry; and most recently with Ganteaume and McMullen.

From **Dave Joy** of Sarasota we have learned of the death of **John Harvey Zimmerman** of Westport, Conn., on May 20, 1976. Born in 1900 in Chicago, Ill., he received his B.S. and M.S. degrees in Mechanical Engineering in 1923 and 1924. He began his career on the staff of M.I.T.'s Mechanical Engineering Department. In 1936 he left to serve as Director of the Linde Division of Union Carbide Engineering Department in Newark. Until retirement in 1965 he held various positions in the fields of Gas Process, Apparatus, Machine Development and Sales. At one time he was affiliated with the "Manhattan Project" engaged in liaison work on the "A" bomb. — **Thomas E. Rounds**, Secretary-Treasurer, 990A Heritage Village, Southbury, Conn. 06488

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The most exciting event of Technology Day '76 for our Class was the "Ceremony of Adoption," wherein **Irwin W. Sizer**, recently retired Dean of the Graduate School, became an Honorary Member of our Class. He was graduated from Brown University in 1931, gained a Ph.D. from Rutgers in 1935, then joined M.I.T. in Biology. Advancing through physiology professorships, he headed the Department of Biology in 1957 and became Dean in 1967. He is internationally known for his studies of the properties and applications of enzymes. Dr. Sizer was presented a certificate by **Frank Shaw**, Class President. Assisted by **Herb Stewart** and myself, the Dean replaced his flashy mint green jacket with the traditional cardinal, and donned a '24 red and white cap, our 50th Reunion symbol. Thanks to his good wife, Helen, the jacket fit perfectly.

Frank, with his effervescent wit, avoided any dull moments and steered the group to personal revelations of retirement activities. **Gene Quirin** gave us some inside facts on Babson's Reports history. **Johnny Fitch** summarized his efforts with a quip: "A retired man was asked, 'What do you do with your time?' He replied, 'Nothing! and I am three weeks behind!' "

Gordon Billard commented on how to parlay a million-dollar portfolio. **Ed Moll** expounded on his favorite project — Sturbridge Village, an outstanding replica of a prosperous New England village in the 1776-1826 period. **George Knight** and Edith have been spending their winters in England; and plan to forsake the bay view of Hingham, Mass., for the mountain scenery of Peterborough, N.H. (George may have state taxes in mind.) **Harold Hazen** related his very interesting contact experiences with Saudi Arabian authorities, both oil and royal, by invitation.

Herb Stewart ascribes his good health to his three sessions weekly on the tennis courts. Upon being urged, he outlined his several recent awards and honors. He is an active member of five professional standing committees and an emeritus member of one more. He also finds time to consult, principally to Charles T. Main, Inc., engineers. **Frank Shaw** is treasurer of a "Golden Ager" organization and carries on a small sideline producing and marketing a fireplace "Logger."

Don Fife enjoys his continued work as District Manager of the Aerofin Corp. We found Frank Achard, '13, strolling around the campus, unable to locate any of his less hardy classmates, so invited him to join our group for dinner. I'm serving on the Town of Brookline Zoning Board of Appeals and am a Trustee of the church Endowment Fund, Board of Overseers, and my Condominium Trust, supervising the maintenance of two buildings.

Finally, Irwin Sizer, our new Class member, commented that he will continue to devote his talents to M.I.T. as President of the Health Science Fund and Consultant on Resource Development.

It appears that Mary and Johnny Fitch have always had misgivings about the way Antony and Cleopatra carried on in Egypt, so in September they will explore the Nile to determine its amorous potential and return to Florida in October.

About 20 members gathered for the luncheon in Rockwell Cage, so we had our annual glimpse of **Del Kendall** and **George Glennie**. We witnessed the presentation of the **Gordon Y. Billard** '24 Award to two receipients. The award was established in 1963 in memory of Gordon's mother and is given for "special service of outstanding merit performance for the Institute."

The Grim Reaper has taken two more from our ranks. **James L. Guion** resided in Springfield, Mass., and died January 27, 1976. He earned a Ph.D. at the University of Chicago in 1928 after some time in mechanical engineering at the Institute. Circa 1949, his office was in the Hawaiian Ordnance Depot at Honolulu.

Thomas T. Stevenson passed on April 26, 1976, in Scottsdale, Ariz. He gained his S.B. in mechanical engineering. Ox was a Reserve Officer in the U.S. Army until 1949 and at one time was a hydraulic designer, statistician, engineer, and actuary, but our records on his career are scanty. He was awarded the Distinguished Service Medal as a Colonel on the War Department General Staff.

Notes from Alumni Fund evelopes: **Paul Cardinal** writes: "Two more grandchildren in February brought our total up to 29. Flew to Houston for the christening of one on Palm Sunday, then to San Francisco for Easter with our oldest son Paul, Jr., and family." . . . **Clint Conway**: "Having a grand cruise up the Tennessee River with Eva and **Jack Walthall** on their yacht." . . . **J. Earl Frazier**: "For distinguished achievement in ceramics has received the John Jeppson award. The presentation of the gold medal and scroll was made at the 78th Annual Meeting of the American Ceramic Society in Cincinnati on May 3." . . . **Stanley A. Higgins**: "I am still working as a Resident Engineer for Anderson-Nichols & Co., Inc. The last three years, I have been working in New London, Conn., Sunapee, N.H., Farmington, N.H., and Haverhill, Mass. However, I take time off during the winter months now." . . . **Sanford C. Lyons**: "Retired last July. Said to be 'Consulting.' "

The National Medal of Science is the nation's highest award for outstanding achievement in science and engineering. In June, 1976, President Ford announced the selection of 15 outstanding Americans designated as the 1975 recipients. One of them was **Frederick E. Terman**, now living in Stanford, Calif.

Phil Blanchard has been elected the Senior Vice President of Wyatt, Inc., New Haven, Conn. He has been responsible for many innovations in water terminal operation methods widely copied by major oil companies.

The *New Haven Register* of May 3, 1976, carried a long article and picture of **Theodore W. Kenyon**, headed "Test Pilot of World War II Is Still Flying High." Ted founded Kenyon Instrument which was bought out by Sperry, but still turns out delicate and critical instruments for ships and planes around the world. He and his wife were, and still are, avid fliers. They celebrated their 50th wedding anniversary in September. Teddy (Ted's wife) today cruises about in a neat, single-engine craft seating four, quite a come-down from the Navy Hellcats, Grummans, and P-38s tested years ago.

Frank Shaw entered the Massachusetts Eye and Ear Infirmary August 12 for removal of a cataract in his right eye. Now he must decide on a contact lens or monacle. All suggestions will be studied closely. — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, Mass. 02146; **Herbert R. Stewart**, co-Secretary, 8 Pilgrim Rd., Waban, Mass. 02168

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We were well represented at Technology Day by **Will Gardiner**, **Jim Howard**, **Ed Kussmaul** and Adele, **Stan Lane**, **Ed McLaughlin**, **Frank Mulcahy**, and yours truly. Our president, **Chink Drew**, had planned to come, but flu delayed his annual trip back to Portsmouth, N.H. **Sam Spiker**, whom we expect to see each year, was observing his 55th Reunion at the Hill School.

Since the last notes, many memos have reached me thorugh the Alumni Fund Office. These are much appreciated. **Ken Lucas** is directing a School of Surveying with the Eastern Mass. Assoc. of Land Surveyors. A continuing education project for those in the land surveying field, it is run by correspondence, and at present has six faculty members and about 150 students in 30 to 40 states. . . . **John Ramsey** says nothing new to report, he is tending his invalid son (in a rest home) which prevents travel. . . . **Harold Bishko** has five children and eight grandchildren scattered all around the U.S.A. . . . **Frank Preston** is retired and enjoying farming. . . . **Arch Nickerson** sends his regards to all.

Tom Nelson sends greetings from Lakeville, Mass., where he has summered since 1912, on land acquired from the Indians by third generation Thomas Nelson in 1714. Tom liquidated his business and retired in 1970 and now spends six winter months at Clearwater Beach, Fla. . . . From Sarasota, Fla., **Alan Crowell** reports that there are many alumni in the area and at the annual picnic in April nearly 100 were in attendance. **Arthur Sharp** was the only other '25er present. . . . **Mary Tripp** reports no news because of ten months of illness which prevented her attending the International Conference of the Society of Women Engineers held in September, 1975 in Cracow, Poland. . . . **Henry Sachs** continues to be most active in the voluntary field. He was recently elected as a vice president of the Education Alliance, a trustee of the Federation of Jewish Philanthropies of New York, a member of the Executive Committee of the National Council for Homemaker-Home Health Aide Services, a director of the Council on Social Work Education, and a board member of Vacation Camps for the Elderly. . . . **Doug Martin** has retired for the second time. His wife suffered a stroke last November and he has been busy getting her back to a healthy condition which it is expected will require approximately a year.

Frank Cole has entered involuntary retirement because of an office fire, physical problems, etc. He is still consulting architect for the University of North Carolina at Chapel Hill, but there is not much activity there. He and his wife Dorothy have had successful cataract operations. Elinor and Sam Spiker have called on him and **Sonny (Bill) Sonnekalb** dined with him a few months ago. . . . **Edward Zetterberg** notes that his grandson, William Dupont, received his B.S. in Course V in June and is now doing graduate work at M.I.T., while his wife is taking graduate studies in chemical engineering. Edward's health does not permit him to travel at the present time. . . . **Ed Wildner** writes to say how much he enjoyed the 50th Reunion. . . . **Fred Greer** still enjoys nice winters in Naples, Fla., but finds his new home in New London, N.H., best for the summer. . . . **Chester Currier** writes from Worcester, Mass., to say that he and his wife Elizabeth are enjoying retirement and observe their 44th wedding anniversary on July 16. . . . **Herb Hubbard**, who resides in Princeton, N.J., tells us that the group of M.I.T. alumni living in that area have been meeting informally for the past year and have now formed the M.I.T. Club of Princeton. Herb has accepted election to the Board of Governors. So far he seems to be the only member of our class in the area. If there are others in that vicinity, please make yourselves known to the officers of the new club.

Fred Cunningham telephoned recently. He was in Plymouth, Mass., staying at the home of his late brother, trying to settle some estate matters. Fred continues to be active in his company, Cunningham Industries Inc. of Stamford, Conn., although he has relinquished many of the management responsibilities to his son.

It is with sorrow that I must report the passing of two classmates. **Frank P. Van Deren** died in Santa Rosa, Calif., on January 1, 1976, and **Robert E. Huthsteiner** passed away in El Paso, Tex., on March 11, 1976. — **F. Leroy (Doc) Foster**, Secretary, 35 Woodland Way, P.O. Box 331, North Chatham, Mass. 02650

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Our 50th Reunion is now a memory but what a *fond* memory. As Class Secretary I find these reunions frustrating as well as pleasurable. I would like to spend the entire reunion with each of you personally but have to be satisfied with fleeting conversations. I took many pictures and have lots of prints for the '26 Album. Pictures of Dr. Wiesner's reception; pictures at McCormick Hall; at the Friday Luncheon and at every opportunity possible at Chatham. The one characteristic is that everyone is smiling! The prints are jumbo size which from 35mm is about 3½ x 5 inches, so if you have any slides or Kodacolor prints you would like to add to this collection or of previous reunions we will be delighted to add them to what we have. **Jim Killian** has contributed a lot of Polaroid pictures he took, plus a couple taken from a ladder that collapsed and left the poor photographer (who appeared to be about our age) flat on his back. We understand that he suffered painful sprains but has recovered. Lucky Jim handed him the camera instead of climbing the rickety ladder himself. We hope to work out a method of shipping the album to various locations where '26 men may gather or frequent so you will not have to wait for our 55th reunion to see the pictures. And the audio-visual recording of the reunion can hopefully be sent around the same way — after editing. We are waiting for the activities of summer to pass before the committee gathers at **Bill Meehan**'s establishment for the editing, but those of you who saw the replay before we left Chatham on Sunday morning are aware that the Class of '26 has achieved another milestone with this recording.

Don Cunningham, our reunion chairman, left no detail unattended and we owe him our respect and thanks for his flawless performance. As a matter of fact he did such a fine job that he has won the assignment of arranging our 55th reunion, even though he may be learning of it for the first time as he reads these notes. We asked Don to review our reunion experience and he was very prompt with his reply: "Dear George, We certainly had a 50th Reunion to be proud of. This includes the reception at the President's house, our group at Pops, and especially our Class Gift. We then started on our own special reunion of fun and good fellowship at the Chatham Bars Inn in Chatham, Mass., on Cape Cod. I found the Committee support to be outstanding. Their efforts made the weekend one we will never forget. Those classmates who haven't taken advantage of our reunions don't realize that this is not only an opportunity to renew friendships established at Tech, but a wonderful way to convert nodding acquaintances at Tech to very close friends, and to have a marvelous weekend.

"We had 113 classmates, 86 wives, three widows, and an undetermined number of guests. Two of our distinguished guests were Priscilla and Paul Gray, Chancellor. Liz and Jim Killian were of course with us, and Jim gave a thought-provoking talk at our banquet. **Dave Shepard** gave recognition to a number of classmates for their efforts for the Class and for Tech, especially to **George Smith**, our outstanding Secretary, for his efforts as Chairman of the Sailing Pavilion Committee and their fund-raising activities. **Thornton Owen** was thanked for his excellent work on our Class Gift. Dave was unanimously elected President of the Class for life. As you know he is also a Life Member of the M.I.T. Corporation.

"In addition to the many social groupings throughout the weekend, we had a clam and lobster bake on the beach, Edna Landau and her national award-winning slide shows, and one by **Ray Mancha** and his wife on Williamsburg, dancing to an orchestra that really could help you remember the Techtonians. Dave and Ray brought us back to the '20s with their banjos. On top of all that Bill Meehan had the reunion put on videotape including discussions. It was very interesting to watch and hear the replays. Bill Meehan, with his technologically sophisticated equipment, plans to treat us at our 55th with our 50th shenanigans.

"In spite of all the fun, your committee was aware of the classmates who directly and indirectly communicated their reasons why they couldn't come. They were with us in spirit, but in too many cases, unfortunate events affecting them or their families were the reason.

"Reservations for our 55th are already made at the Chatham Bars Inn. Make your plans to be there! — Dave C."

There is so much to say that we will be continuing the reunion comments all winter and will welcome your observations to be included. We have a list of all who attended our 50th and will send a Xerox copy to anyone who would like it. One little incident that many of you will recall had a happy ending. On the evening of our arrival my C.B. radio was "ripped off" while we were at dinner with the car in the custody of the doorman at the Inn. Insurance took care of a part of it but the policy was $100 deductible. When I wrote the Inn owner about his responsibility I sent copies to the proper people in the M.I.T. Alumni Association. A few days later a check for $100 came from the innkeeper and strangely his letter was copied to the same people at M.I.T. I guess they like our business — and it really *is* a great place for a reunion.

I'm writing on a rainy Sunday morning at Pigeon Cove. A Star Boat regatta had yesterday's two races cancelled because of a wild nor'easter, but I can see the boats heading out in the downpour so I must leave you to don my foul weather gear and get out to see the excitement, but I'm sure hoping the Race Committee takes pity on the rest of us who are not quite so "gung ho" when our afternoon race comes up. But if they go out I'll be there. So I'm off to the Yacht Club with a Cheerio to all. — **George Warren Smith**, Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

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Nat Cohn's latest honor is an honorary degree from R.P.I., awarded at this year's Commencement for his innovative contributions to the field of control systems for the electric power industry. Nat retired as executive vice president of Leeds and Northrop in 1972. Nat has previously received the Lamme medal of the I.E.E.E., the John Price Wetherill medal of the Franklin Institute, and the Albert T. Sperry medal of the Instrument Society of America, and was elected to membership in the National Academy of Engineering. And, as faithful readers of this column will recall, he has written extensively on automatic control of generation and power flow, including the definitive book on the subject.

Paul Ring has just celebrated his golden wedding anniversary; he met Eleanor (Murray) while a student at M.I.T. Seven children, 21 grandchildren, and 100 friends helped him and Eleanor celebrate.

Elmer Andrews isn't far behind Paul; he reports that he has been happily married for 47 years, and he and his wife both enjoy good health. Elmer has two sons and six grandchildren. He retired from Eastman Kodak in 1967 after 40 years' service and spends his winters in Florida or Arizona. He and his wife keep busy with church work, gardening, ocean cruises and other travel, and the grandchildren.

Two classmates report that they are living in retirement communities — **Al Billings** in Leisure Towne in Vincentown, N.J. and **Bob Engel** in Heritage Village, Southbury, Conn. (Fran Bonnar, who is now Mrs. Albert Hendershot, also lives in Heritage Village.) Bob mentions that he ran into **Larry Day** at Manesota Beach, Florida; Larry's

home is in Fairfield, Conn., and he is semi-retired. Al Billings occupies himself with visits to his daughter and her family, who live nearby, and antiquing.

LeRoy Miller is still operating his tree farm, with his wife, in Rockbridge, in southern Ohio. . . . **Brad Stetson** chose Florida for his retirement; **Harry Moser** is in Asheville, N.C.; and **George Houston** in Camden, Maine, and all report that they are enjoying life. George and Mary Houston spend winters in Florida between St. Pete and Daytona. George and Mary are gardeners; George is a Senior Active Rotarian and keeps active in civic affairs — the local school system and the Penobscot Bay Medical Center.

Frank Kear is still a consulting engineer in Washington, D.C., where he is a member of the task force for Directional Antennas, Interference, Coverage Criteria, and Power Limitations. . . . **Herb Johnson** writes that he and **Harry Franks** are launching a business geared to innovation, such as his solid-phase scrap metal recycling process or Harry's "lifetime" spark plug. . . . **Andrew Canzanelli**, who retired as head of the Department of Civil Engineering at Wentworth Institute, is one of the older members of the class; he writes that he is now 83.

I have, unhappily, three deaths to report. **George Bennett**, widely known as an expert in educational psychology and formerly president of the Psychological Corp. in New York, died last December.

Charles Frank passed away in Wheaton, Ill., in March, after a short illness. He was with Automatic Electric Co. of Northlake, Ill., from 1934 to his retirement as Director of Laboratories in 1967. He is survived by his wife, Ruth (Walker), and a son, William Arthur.

Colonel **Albert H. Burton** died in December. He had served in the Army from 1925 to 1947, with the responsibility of Director of Real Estate for the War Department in his last two years. After the war, he held executive positions with the Roma and Cresta Blanca wine divisions of Schenley Industries.

As these notes are written in early August, your secretary has been busy helping to select his successor and will retire as City Treasurer of New Rochelle on August 30. — **Joseph H. Melhado**, Secretary, 24 Rodney Rd., Scarsdale, N.Y. 10583

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We had a very good attendance of classmates at Technology Day this year: Rose and **Maury Beren**, Jan Chamberlain, Frannie and **Jim Donovan**, Dorothy and **Carney Goldberg**, **Fred Lewis**, Marge and **Mac McDermott**, Mary Nichols, Gladys and **Dave Olken**, Anne and **George Palo**, Florence and **Walter Smith**, Ann and **Ford Tibbetts**, and Ruth and **Abe Woolf**. It was a most enjoyable occasion — both pleasant and instructive.

At least one '28er is living in the ideal retirement environment. **John Houpis**, in two enthusiastic letters from Greece, writes of his well being and contentment amid the beauty and serenty of his citron farm (2,000 trees) near Corinth. Although alone since the death of his wife, Kiki, nearly four years ago, John has frequent visits from his two sons who live in Athens. One son has two little daughters described by John as "blonde beauties."

Also enjoying retirement is **Herb Dayton**, who says that he and wife Charlotte are in good health. They live on five acres only ten minutes' driving time from Houston, Texas. They are great Houston boosters, though each summer they spend a month of vacation in Colorado. Herb still has some industrial contacts but keeps busy mostly with a big flower and vegetable garden, church interests, family, and friends. He was kind enough to say that he enjoys reading about his classmates in the *Review.*

A letter from **George Chatfield** developed the following story: After a fire in Fitchburg, Mass., a brick building was demolished thus exposing an adjacent brick wall which had been hidden for many years. The uncovered wall carrried a huge 50-year-old advertising sign: "Uneeda Biscuit — 5¢." George, who (among many other activities) is president of the local newspaper, *Montachusett Review,* had the sign photographed. He sent a print of the picture to Nabisco, Inc., the Uneeda bakers. Knowing of the M.I.T. '28 relation, the communications director at Nabisco sent the picture and George's letter to **Ray Wofford** in California, who retired from Nabisco in August 1968. Ray spent most of his professional life with Nabisco, beginning in 1933.

Clifford Webster's wife, Esther, wrote an interesting letter on behalf of Clifford. He is now 85, they live in Florida and he still golfs three days each week. Back in 1914 Clifford delivered the first plane for the Canadian Air Force from the Burgess Co. in Marblehead, Mass., shipped to East Alburg, Vt., for assembly, then flown by Clifford over the border to Quebec City. Clifford was interviewed about this historic event for the C.B.C. television series "Flight, the Passionate Affair" scheduled on four successive Sundays from 10 to 11 p.m. starting September 19.

It is always a special pleasure to have correspondence from the wives of deceased classmates. Recent notes have been from Betty (Mrs. **Walter H.) Ridley**, Anna (Mrs. **William H.) Woods** and Dora (Mrs. **David) Mathoff**. . . . **Jim Donovan** is a prolific letter writer. One consequence is that he receives a lot of mail from classmates and so becomes one of our best sources of class notes material. Via this route we learn that **Bill Erickson** is keeping himself busy — in early May he was "starting to gety the islands in Maine opened up for the summer." . . . **Ed Pitt** has moved from New England and the paper business to Florida and into the plastics field. . . . **Gerry MacGillivray** attended the change of command ceremony when his son, Commander Kenneth A. MacGillivray, was installed as Commanding Officer, Fleet Composite Squadron Ten, U.S. Naval Station, Guantanamo Bay, Cuba. Despite a period of illness (or because of it?) Gerry received V.I.P. treatment and enjoyed his stay at the base. Jim has been very hard at work on the 50-Year Class Gift, and reports that '28 is doing well. At the close of the recent Alumni Fund campaign year we were sixth among all classes with $117,046 donated and 54 per cent of the Class participating. We now have less than two years left in which to complete our gift. Please send in your contribution to Jim or write and tell him if you are planning a gift by will or other deferred means.

We have several Alumni Fund envelope news panels with these notes: **Frank McGuane**, whose sixth grandchild was born in February, is very busy with parish activities and the village seniors. . . . **Herman Krantz** writes that he is still in Italy and that his health is better. . . . **Dick Goble** says that, except for old-age arthritis, he and Ruth continue as always. As for attending the 50th, only time will tell. . . . Pam and **Rene Simard** returned from a trip to Florida this past spring via New Orleans, hoping to find a place to settle in away from the cold and snow. They enjoyed the trip but had no definite results. Both are in good health.

With deep regret we must report the deaths of two classmates. **Philip M. Clark** died on March 18, 1976. Philip was a native of Boston; he studied at the Noble and Greenough School and attended Princeton University prior to entering M.I.T. He was president and later chairman of the board of the New England Confectionery Co. He was also a retired commander, U.S.N.R. Besides his wife, Marion, he left two daughters and five grandchildren. We talked with Mrs. Clark and expressed sympathy for the class. **Edwin S. Kant** died June 25, 1976. Ed studied at Stevens Institute before enrolling at M.I.T. His early technical work was on lighter-than-air craft at Goodyear. Later he went with General Electric Co., then was with United Shoe Machinery Co. for 26 years. Our sympathy goes to his wife, Marion, and son, Alexander. — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, Mass. 01890

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Once again the flaps of the Alumni Fund envelopes have saved the day; little news has come from other sources. . . . **Ed Giroux** reports that he and Mildred continue to divide their time between Maine and Florida. Both Ed and Mildred are artists and devote all of their spare time to painting and art shows. . . . **Reg Bisson** has retired from his general contracting business, W. M. Bisson & Son. He expects to continue working part-time as a construction consultant and estimator in Laconia, N.H.

George Gassett retired from Stone & Webster Engineering Corp. in July, 1974. For the past year he has been working as a nuclear consultant with EBV Systems Division of Gulf & Western in Warwick, R.I. . . . **Rudolph Israel** reports that subsequent to his retirement, he was awarded a citation for "outstanding service to the engineering profession" by the Engineering Council of Sacramento Valley, Calif. . . . **Les Engler** retired from the staff of C.C.N.Y. in 1973. The Englers have moved their permanent home to Quechee, Vt., and plan to spend the winter months in Fort Lauderdale.

Willard Morain reports that he is still consulting on a steady basis for his old company, Cooper Energy Services. Four of his five children are now through college with the fifth in graduate school. His eldest son Dick recently was made a Lieutenant Colonel in the U.S.A.F. . . . **Win Hartford** reports that his wife, Mary, who originally attended a non-degree college, decided about a year ago to complete the requirements for an A.B. degree. She graduated from Belmont Abbey College (N.C.) with the Class of '76 and had the dubious honor of being the oldest coed in the graduating class.

Ruth and **Irving Dow** both had some health problems last spring but are now reportedly doing fine. They are planning to give up their home in Bethesda, Md., and move to Leisure World where there is "less space and no maintenance." . . . **Al Bird** has retired from his civilian job with the Department of the Army and is living in Rockport, Me. He was elected to a three-year term as Selectman in 1975. He reports his hobbies are sailing, boat building, and furniture making.

Mannie Birnbaum has also retired but is still director of a number of Canadian companies, including Protein Foods Corporation, Ltd., of Hamilton, Ont., Universal Foods, Ltd., of Toronto, Hybrid Turkeys, Ltd., of Kitchener, Ont., and Fastforms, Ltd. of Guelph, Ont. Mannie is a past chairman of the Board of Governors of the University of Guelph. The Birnbaums have three sons: a physician, a lawyer and an advertising man. . . . As of June 1, 1976, **J. Palmer Boggs** fully retired as a Professor of Architecture at the University of Arkansas. He is continuing to practice as a consulting structural engineer in Fayetteville, Ark.

We have at hand a notice that **Ormond Lissak** died on March 14, 1976. According to my records, he retired on June 30, 1973, as Administrative Assistant for the Department of Public Works of the city of Mountainview, Calif., after about ten years in that position. He had previously worked for Kaiser Engineers. At the time of his death he was living in Sunnyvale, Calif.

I recently received notes from both **Ralph Peters** and **Bill Waite** enclosing clippings reporting the sad news that **Stan Wells** died suddenly of a heart attack on July 7, 1976. As most of you know, Stan worked for Eastman Kodak Co. throughout his career, retiring in 1973. In recent years, his work had been with Kodak's Color Film Division. His first wife, Anne, whom many of you will remember from class reunions, died several years ago and his second marriage to Florence Smith of Rochester was reported in the June, 1976, Class Notes. Stan is survived by his mother, a son, Stanley C. Wells, Jr., and three grandchildren.

Change of address: **V.I. Thormin**, Apt. 1202, 525-75th Ave. S.W., Calgary, Alberta, TZV IR8 — **Gordon K. Lister**, Secretary, 530 Fifth Ave., New York, N.Y. 10036

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Anyone who missed our 45th Class Reunion,

really missed a great time. Jan and **Larry Barnard**, our General Chairmen, and their Committees' efforts paid off. The only adverse cricicism I heard was that it was a little harder for everyone to get together because there were so many other five-year reunions being held on campus at the same time.

A note from "Skeets" **(A.G.) Dean** says that he has been retired since 1969 from the Budd Co., where he worked since graduating. He has kept up his old contacts by consulting for the Budd Co. and others; and has been able to do a lot more traveling, hiking, climbing canoeing, and skiing than before. . . . **Donato Grieco** tells me that he is presently engaged as Project Engineer for the new $8-million Bus Terminal Project in Buffalo, N.Y. After its completion late in 1976, Don is planning to make Cape Cod (Chatham) his home and achieve a lifetime ambition of fishing, sea food, and ocean breezes. Believe it or not, this is his sixth retirement. . . . Although he retired from Standard Oil Co. of California in 1974, **Don Loomis** was too busy with community projects to travel East for the 45th Reunion. . . . **Bryce Prindle** is retiring this year from Professorship at Babson College and plans to emigrate beyond the Cape Cod Canal. He hopes to continue research on the engineering aspects of shark bite as applied to deep-sea mooring lines. Harriet's and Bryce's address is: Box 895, 36 Wabash Ave., Pocasset, Mass. 02559.

Charles Bicking writes that he has been invited to present a paper on "Sampling of Biological Materials" at Staqvarel, Prague in September and on "Laboratory Evaluation" in Buenos Aires to the Argentine Society for Quality Control on November 15. . . . **Pat Harney** says local boatmen from down east would like to read more about the Herreshoff-designed dinghy — which was briefly described in *MIT 76*. . . . **Warren Dickinson** writes that he retired from McDonnell Douglas after 38 years in aircraft manufacturing and engineering. He seems to be enjoying his retirement and is now living in Los Angeles. . . . Mabel and **Jack Kalman** unfortunately couldn't make the Reunion because Jack is physically unable to travel. . . . **Arnold Childs**, who retired from Sun Oil Co., and his wife, Rita, live in the White Mountains but spend winters in Siesta Key, Fla., or world traveling by freighter. . . . **Leon Osinski** has retired and is now doing some traveling. He spent part of the summer in Poland. . . . **Mason Burrows** retired from the Norton Co. in January, 1974, and is now doing consultant work as a ceramic engineer for Norton and others on the Cape. At present he is developing pottery bodies and glazes in his cellar at North Eastham, Mass., between sails on his Tartan 27. Mason is also active in the Coast Guard Auxillary and is now serving it as Public Education Officer.

Joe Buswell writes that he has moved to Sun City, Ariz., and is enjoying their $12 million of recreational facilities. In May through September, Joe and his family return to their property at Jefferson Beach, near Kingston, Wash., where they live in a 27-foot travel trailer. . . . Congratulations to our Prexy, **Howard Richardson**, on his election as Term member of the Corporation of M.I.T.; and also to **Gordon Brown** on being named the 1976 recipient of the Robert Fletcher Award by the Thayer School of Engineering at Dartmouth College.

A most welcome letter from **Bill Metcalf** follows: "I regret to have been negligent over the past 45 years in never submitting any news to you about my personal activities and my professional work. There is no question whatever that my training at M.I.T. and the fact that I graduated from that prestigious institution, were important factors in promoting my career. The research I have done and the continuous advancement in faculty rank and responsibility were based in no small measure on my M.I.T. background. I have been married for 25 years to Dr. Stefanie Lichtenstein, who was a physician practicing anesthesiology. She was on the staff of the Hospital for Special Surgery at Cornell but retired three years ago. We do not have any children. I have been on the full-time faculty of the Albert Einstein College of Medicine for 22 years and joined that faculty in the Department of Surgery the day the school officially opened. I will be retired this June 30 but will be kept on the faculty on emeritus status." After graduation from M.I.T., Dr. Metcalf obtained his M.D. in 1937 from Johns Hopkins School of Medicine. His military service included general surgery; he was Assistant Chief and Chief of Hand Surgery at William Beaumont General Hospital in 1945 and 1946. His professional career includes practice at Hines V.A. Hospital, N.Y.C. Diplomate of the American Board of Surgery in 1948, many hospital and teaching appointments, a number of research publications and membership in nine professional societies.

During the Reunion, I enjoyed chatting with so many of my classmates and wish I could have taken notes on all of their activities. Unfortunately, I couldn't spread myself that thin (my doctor says I should lose 50 pounds) — but was able to obtain the following. Catherine and **Bill Nixon** commented on how much they were enjoying their first reunion. Their address is Rt. 4, Box 24, Hertford, N.C. 27944. . . . **Herbert Chandler** retired as of April 1. . . . Fred Fay, '32, who has lived in Indianapolis since graduation working for Western Electric Co., has also retired. . . . **Kendall Clark**, also retired, lives in Poughkeepsie and is now doing consulting work. . . . **Dick Ashenden** reports that he is still working but has more vacations. . . . **Johnny Bolanos** and Julieta are retired — have 16 grandsons and one great-grandson — also one of the grandsons is at M.I.T., Class of '77. . . . **Cliff Walker** says he retired in 1972. He and Kay reported they really were enjoying the 45th Reunion — also said they have one daughter and one granddaughter. . . . **Jack Allia** is another retiree. He and Sophie have two daughters and four grandchildren. Jack keeps busy at the Retired Men's Club. . . . Harriet and **Ed Blake** moved from Wayland, Mass., last August to Jaffrey Center, N.H., where they now live for seven months of the year. Their winters are spent in Englewood, Fla. Ed is also retired and he and Harriet have one married daughter and two grandchildren in Windsor, Conn. Back in 1963, Ed resigned as a vice president of a metal decorating company in Chicago. Both he and Harriet wanted to get back to New England, so Ed became a manufacturers' representative for several machinery manufacturers and has been enjoying it for the last 12 years.

Sally and yours truly finally decided to move to Florida — P.O. Box 1241, Mount Dora, Fla., 32757, phone 904-383-3472. We have a house all on one floor on Lake Beauclair. One of these days we hope to get fully settled but I suspect it will take some time.

Sadly we report the following deaths reported since the last notes: **Edward F. Abbott**, August, 1975; **John H. King**, April 12, 1976; **Charles D. Luke**, April 18, 1976; **Chesley S. Young**, April 13, 1976; and **John R. Vincent**, May 14, 1976. Our deepest sympathy to their families. — **Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, Fla. 32757; Assistant Secretaries: **Ben W. Steverman**, 260 Morrison Dr., Pittsburgh, Penn. 15216; and **John W. Swanton**, 27 George St., Newton, Mass. 02158

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Manson Benedict recently was designated by President Gerald Ford as one of 15 recipients of the National Medal of Science. This is the Nation's highest award for outstanding achievement in science and engineering. . . . **Bernard S. Gould**, Professor of Biochemistry and Undergraduate Registration Officer in the Department of Biology at M.I.T., recently received one of the Gordon Y. Billard Awards for special service of outstanding merit performed for the Institute. In making the presentation, President Wiesner said of Professor Gould, "Your extraordinary service of a number of years as academic advisor to many generations of M.I.T. students sets the highest standard of M.I.T. performance.". . . . Among the faculty retirements in June was **Carroll L. Wilson**, Mitsui Professor in Problems of Contemporary Technology, at the Sloan School of Management. He was appointed professor of industrial management in 1961, and Mitsui Professor in 1974. Since 1974 he has been director of the Workshop on Alternative Energy Strategies, involving participents from 15 countries and recently delivered an address in Oslo, Norway, at a major conference on energy conservation.

B. Edwin Blaisdell was among the retiring faculty members of Juniata College, Huntingdon, Penn., who were honored by the trustees and faculty at their annual dinner. He had been a member of the Juniata faculty since 1954, starting as a lecturer in chemistry, appointed as a professor in 1956, and became Chairman of the Department of Mathematics in 1961. . . . **Theodora Keith** is actively engaged in Ronald Reagan's political doings. She has moved with her five cats from Cambridge to Bethel, Vt., to winter where she has spent 50 summers and states it is admittedly absurd to oscillate between two little white Cape Cod houses within eight miles of one another in the same climate, scenery, and state. But Vermont pleases her and she hopes that three winters there will have served as sufficient initiation to be rated a Vermonter at last. . . . **Milton G. Leavitt** retired July 1 as Assistant Principal of the Automotive High School, Brooklyn, N.Y. . . . **Ed McCormick** has come out of retirement to become a Chemist-Operator for the Jekyll Island State Part Authority. After four-week long school sessions and five exams he is now a certified Grade II Groundwater and Wastewater Engineer for the State of Georgia, with the Grade I exam in the offing. That Jekyll Island location sounds like a nice spot to be "actively" retired.

E. G. Roberts remains very busy as Corporate Director for Engineering of the Hospital Governing Commission of Cook County, Ill. — a $160-million corporation overseeing three Public Hospitals in the County. He has been the author of numerous engineering and technical papers and as an engineer on the Argonne Particle Acceleration Experimental Team, co-authored papers presented at the Stanford — Harvard Universities International Magnet Conferences. . . . **J. Paul Breden** proudly announces he is "baby-sitting" with five granddaughters in Florida. . . . **Thomas H. Jenkins** is back home again in Houston, Texas, after spending four years in Washington, D.C., as a Director on the Natural Gas Phase of the Energy Program. Tom extends the following invitation: "Should any '32 members journey through Texas — I would be pleased to be host to a good long julep."

Stan Johnson retired as town engineer of Harrison, N.Y., January 1, 1976, and has gone into business for himself as a free-lance consultant. . . . **Alfred A. Mulliken** is enjoying retirement in Florida not only with his golf activities but also as a volunteer in the SCORE program — the Services Corporation of Retired Executives in the Southwest Florida Chapter. Seventeen months of retirement in the Florida sunshine more than compensate for the previous 20 years in the New York City area according to his report. . . . **George Tilson Weed**, after residing continuously in Tokyo since V-J day, except for annual business and vacation trips to the United States plans to retire in Honolulu by mid 1977. George is now living in Hayama, near the big Bhudda, next door to his oldest daughter with four grandchildren. For relaxation he enjoys weekend seashore strolls or golf and an occasional ski holiday in northern Japan.

Benjamin Wilbur, after early retirement six years ago, tells me that two winters in Florida, a trip to Europe, camping, a minihome, gardening, reading, eating out, and woodworking have provided a full program. . . . Your Secretary is in receipt of a long and detailed report from **L. L. Colin**, Salisbury, Rhodesia, concerning conditions in that country — alleging that the psychological war being waged against Rhodesia through many of the news media of the world has escalated to such proportions of misrepresentation that many observers outside Rhodesia find it difficult to separate fact from fiction. He requests a small place in the *Review* to tell us that Rhodesians are going through difficult times — difficult but not drastic, and compared with most countries in the

world today, Rhodesians have much to be thankful for. Anyone interested in more specific details may reach him at the following address: Dr. L. L. Colin, 4 Ascot Road, Avondall West, Salisbury, Rhodesia. . . . **F. Carlyle Roberts, Jr.**, puts his latest report most succinctly, "I am building a house, mostly by myself, for future use if I should live so long." . . . **Philip** and **Helen Benjamin**, after wintering in Florida, have moved back to Brimfield, Mass. Phil stays active with church work, gardening and woodworking. . . . **Dirwood M. Danforth**, after 30 years with the Singer Co., retired December 1, 1975. . . . Mrs. **O. Mason Burrows** is still serving as Treasurer of the Holden Housing Authority but has retired as Supervisor of the Social Workers in Marlboro, Mass. She and her husband have hobbies of ceramic jewelery and pottery and she still holds her rank as first mate on their Tartan 27.

Gaynor Langsdorf, Chairman of the Directors of the M.I.T. Club of Northern California, relates that Ron Stone made a very interesting slide presentation of activities and new developments at the Institute after a recent meeting of the Directors. . . . **Bruno H. Werra** remains active as an Engineering Services Manager in Kenosha, Wisc., producing stainless steel fittings, valves, pumps and automation for the milk, food, pharmaceutical, cosmetic and chemical industries. Unfortunately, the name of his company was missing from the data I received. Bruno is also active in standards work associated with users, sanitarians, and public health service manufacturers. . . . **Harry Schwachman** advises that he has become Professor Emeritus this year and is taking a three months sabbatical. He plans to participate in three international conferences dealing with cystic fibrosis — one in Jerusalem, followed by one in Paris. His term as Chairman of the Medical Council of the International Cystic Fibrosis Association ends at the Paris meeting. He and his wife Hope plan to spend two months in London at the Childrens Hospital and then to return home to his private practice.

It is with sorrow and regret that I report the passing of the following classmates: **Thomas W. Mackesey**, retired Vice President for planning of Cornell University, May 2, 1976; **Walter E. Nichols**, January 3, 1976; **Thomas J. McNaughton**, December 30, 1975; and **Frederick C. Reese**, May 8, 1975. The sympathy of the Class is extended to their respective families. — **John W. Flatley**, Secretary, Apt #204—5100 Dorset Ave., Chevy Chase, Md. 20015

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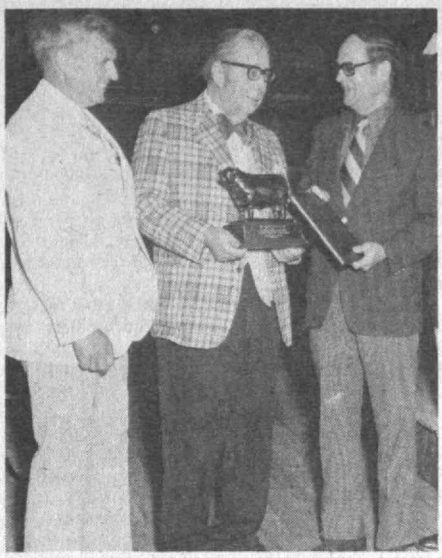
We have a natural for Top Billing this time; **Ellis Littmann**, who was elected to Term Membership in the M.I.T. Corporation. Please note, also, that Ellis is one of two Vice Presidents of the M.I.T. Alumni Association, and, as you must know, he has a good chance to become President, and surely that is the top honor. Our class has already had one Alumni Association President, **Bob Winters**, who was President around 15 years ago. I know that I am authorized to extend to Ellis Littmann our most hearty and sincere congratulations. Viva Ellis.

Henry Kiley comes through with a lengthy letter. He and Betty seem to have survived the rather long Jersey winter, and are (then) enjoying the delightful spring; gardening and house and grounds maintenance. Both are in good health. They make occasional visits to Massachusetts, and an annual trip to California to visit their son and the grandchildren. Henry wonders if our classmates enjoy the notes as much as they do. Henry, they do, though few of them say so in writing. . . . **Stan Walters** is still our pal. He writes about once a year, as I hope that all of you would. One Walters son has received a degree in psychology, and another expects to get his degree in music come September. Daughter Jane has one more year at Arcadia College in Nova Scotia. Dorothy is still very active in the Cheshire Hospital Volunteers, and will be President of the group next year. And, to quote, "the old man is still very busy in his sales work, plus has done a bit of branching out into design of noise absorption enclosures for industrial machinery." After design, he will build them.



Warren Henderson's Beef Barn

When the University of New Hampshire dedicated its Burley-Demeritt Livestock Farm to Warren Henderson, '33, on June 12 "some mighty important agriculture leaders sang his praises, and some highly pedigreed Angus cattle, many of them gifts by him to U.N.H., mooed their approval," wrote Fred B. Beame in the *Manchester Union Leader*.

This newly-named facility houses the beef cattle used for the instructional programs of the Department of Animal Sciences of which Warren has been a long-time supporter. He was also lauded for his assistance to the 4-H Beef Club and his boosts to the Angus industry throughout the years. (From left to right: Professor Gerald L. Smith, Head of the Livestock section in the Department of Animal Sciences; Warren Henderson, and Eugene S. Mills, President of U.N.H.)

I have a letter from Ellis Littmann, in reply to one of mine. He deplored my not making Alumni Day, but was glad to hear why, though he recognized the reason, (Leona's illness). More later on that. Ellis said that he saw **Tom Galvin** and had lunch with Lucy and **George Henning**. **Rich Zimpel** and **W.L. Sorensen** were listed as attending, though they did not use the '33 table. Roslyn and Ellis are taking another trip to the Orient this fall, but before that are taking a week in northern Florida around July 4; the first time in a long time that they have had a chance to travel with both of their children, and their children's spouses. Ellis says it is rumored that **Herb Grier** will assume **Jim Turner**'s job as Class Agent come summer. He is overjoyed that Herb is about to take a more personal interest in M.I.T. and his class. We must regret that Jim Turner cannot continue, as good men are scarce, but, my feeling is that Herb Grier will do a great job.

Norm Spofford came through with, I think, his first letter to me, in which he apologises for not being a very good correspondent. In 40-odd years, Norm has worked for the Corps of Engineers, Sylvania Electrical Products, General Electric, and Western Electric, from which he has recently made his retirement. He has raised four sons, three of whom are in engineering, and he has seven grandchildren. The Spoffords, during May, visited a whole lot of friends and relatives that they have not seen in years. Norm recently moved to Pensacola, and later phoned **Bob Timbie**, who has been in Pensacola for a long time. Now we hear that Bob has been ill, and has had an operation for stones in both kidneys. Norm finds that Bob has recovered, and that he and Ruth will visit one of their children in Europe. I do appreciate your message, Norm, and the return of the prodigal classmate.

We have a press release concerning **Collin Fink**, who joined us to take his master's at M.I.T. Collin took his bachelors at Penn. State, and his doctor's at Columbia. Upon his retirement from teaching at Franklin and Marshall, he received a fine citation fron the President for his long career as a Professor of Chemistry. With the citation he received the F & M traditional "Statuette of Socrates." . . . For some unannounced reason, **Walt Skees** has been generous in sending me commemorative stamps from Spain, where he now lives with his teenage son.

Now for the Alumni Fund capsules, and how I love 'em: short and sweet, and mostly illegible, which allows me to delve into the art of deciphering. There are 15 of them; one is typed. . . . **Walt Swanton** is now retired, and doing a little consulting, but, more to the point, the Swantons have purchased a retirement spot, and are busy fixing up a good house that has been allowed to deteriorate. The new home is four miles north of the old home (in Avon, N.Y. I looked it up), and they will occupy it when they sell the old place. . . . I have already reported on Jean and **Fred Aldridge**, who paid us a visit last winter. Fred has been appointed Chief Engineer of the Miami (Dade County) Health Dept., which, says Fred, is a real challenge. Fine, but what is to happen to the Town Engineer in Chester, Mass? . . . **Jack Adelson** writes that daughter, Robin, is to marry Roderick S. Little in August. Robin is a graduate of Trinity College, and Dr. Little is a Professor of Statistics at Chicago University.

John McAleer has moved from the not-so-deep South to Wickford, R.I., his old home, on the shores of Naragansett Bay, where he will do a bit of coastal engineering, and also some cruising, racing, and fishing. . . . Now for a terse message, which I quote: "Retired — Pan American Airways Engineering Dept. — Power Plant," signed **Wm. C. Hinckley**. I must assume that these statements are chronological. Thanks, Bill. Come see us in Hillsboro Beach, come winter. . . . **Warren S. Daniels** tells us that he has received the Meritorious Award from the Dept. of the Interior, at the U.S. Geological Survey National Center at Reston, Va., April, 1976. Don't drop dead to hear that he has gone to work at long last. He is President of American Fairfax Travel, Inc.

From **Beau Whitton** comes a message I like to hear. Beau is busy lining up alumni to serve on the Education Council, which makes contact with high scool advisors and talks with students who show an interest in M.I.T. Your 25 years on the Educational Council may be no record, but it must be outstanding, knowing you. I worked at that 35-40 years ago, in Cleveland, for a time, but was not good at it. Now, just in — Beau and Daph, via a postcard: "Haven't seen L.B.J.'s cows, but have enjoyed our Texas trip." . . . **Forrest Dexter** writes that he teaches one class per semester at the Univerrsity of Maine at Farmington, and is working on "Environmental Estimates"(?) for use in the teaching. Forrest is one of the retirees to the Northland, and can't understand why anyone retires to Florida or Arizona.

From **E.C. Marshall** comes this: "Past retirement age, but still employed as Director of Mechanical Research, Eimball Systems Division of Litton Industries. Inventing and designing is better than playing golf or loafing." . . . **Ronald A. White** writes that he is still active in his architectural practice, and among the prospects is the preliminary study planning for the Bible City to be located in Mississippi. Work makes you one of a minority group. . . . From **John (Red) Williams**, comes word that he retired from the Kendall Co. in March, 1975, but is doing a little consulting. Red, you don't go to Florida, and won't go to Mexico, so why not drive up to the farm some day soon. After all, you are an old Exeter grad, no?

Warren Webster is still active as a widower,

with plenty of widows about. He's still tutoring a bit, and, if needed, is still a few months younger than Sam Snead, which implies no further similarity. He is sorry, as were we all, to hear about **Norm Levenson**'s passing. . . . **Ed Winkler** says that he is moving into a smaller house following retirement as Chief Engineer of Anderson Power Products, Brighton, Mass.

May I remind all that these Fund capsules are from classmates who have made a donation to the Alumni Fund, and please allow me to assure you that these capsules are very dear to me for that reason. You will already have noticed that you have received no Interim letter this time around, for more than one reason. First, Leona has been very, very ill. On May 16 she suffered a massive stroke, or so it appeared for a few hours. But she shook off the paralysis completely, and a thorough physical, plus a brain scan, revealed that she had suffered a blood clot at the base of the brain. Fortunately, she developed some other way for the blood stream to pass, and started on her way to recovery, which has been very, very slow. I have found that many fellows think that they are strong men. I know of one who found out differently. Leona is now at a point where she is setting up for a permanent wave, which tells an almost complete story. She sends her best to all her many friends among our great group of classmates.

Word has only now come in that **Jim Faria**, of Course II, passed away in July of 1975. We extend our sincere sympathy to Jim's loved ones. Now, fellas, here is another case of a death among us, where the Institute and your secretary were notified almost a year after the fact. I just can't write a letter to Jim's widow now. Won't you fellows listen to me just once, and make arrangements for quick and proper notification of M.I.T. and myself, or me at least? The Institute, via its Officers, are trying to handle these situations quickly and gracefully. Won't you help them out? Urge survivors to act, and quickly. That's it for this time. Come and see us here and in Florida. — **Warren J. Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, N.H. 03833

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I've commented before that this business is "feast or famine" and this is one of the feast months, so if you've been good enough to send in some notes on your Alumni Fund envelope and don't see them here, patience, they will come along.

First some "honors" have come to the class: **Bill Mills** has been elected a term member of the Corporation. I've mentioned before that he is operating a construction business in St. Petersburg. His work for the Institute goes back many years: on the Corporation Visiting Committee for Civil Engineering from 1959 to 1970, a member of the Development Committee since 1965, and a member of the committee of the $225-million Leadership Campaign since 1975. With such a background of service, election to the Corporation seems well merited.

Besides his work in concrete structures and ferro-concrete boats, **Jerry Raphael** has a deep-seated interest in sailing. His letter to our classmate **Gerald Reed** after 40 years of working at the M.I.T. Nautical Association describes that interest: "Jerry and I started as classmates in architectural engineering. Jerry went to sea after his sophomore year, but shortly after he returned to M.I.T. as Assistant Sailing Master. I found myself with three months of annual leave between government engineering jobs, so I spent two months at the sailing pavilion learning to sail, aided by the kindly encouragement of Jerry Reed. Jerry and the sailing pavilion became M.I.T. to me; on every return to Boston I made one visit to the pavilion. As a matter of fact, when I got married in 1940, my bride and I traveled to Boston and sailed at M.I.T. every day of our entire honeymoon.

"To me Jerry Reed has represented the M.I.T. sailing community. I am pleased to know that his contributions to the life of the M.I.T. community are being so significantly honored." Jerry Raphael concludes, "All your news seems to be about retirements these days. I don't have any plans as yet, but it'll come, never fear."

One retirement of our "official" family is that of **Walt Wrigley** who retired from M.I.T. this past June. Walt returned to M.I.T. from Sperry Gyroscope in 1946 as Assistant Director of the Instrumentation Laboratory. In 1951 he became both Associate Professor of Aeronautical Engineering and Associate Director of the Laboratory, and in 1956 he was appointed Educational Director of the Laboratory and Professor of Aeronautical Engineering.

It seems inevitable that each issue must record further losses from our ranks. Unfortunately, we are over a year late in learning of the death of **William Hartz**. I am sure that most Course VI people will remember him and his twin brother Frank, also in Course VI.

In May of this year **John H. Ellison**, U.S.N. Ret., died of a heart attack. Captain Ellison had been one of the Naval Constructors who studied at M.I.T. . . . Finally we have received word from his son of the loss of **Morgan S. Campbell**, of Galveston, Tex. To all the families of these classmates I would extend our collective sympathy.

To wind up, here are some of the Alumni Fund notes I've received. **Harold S. Adams** says, "Retired after 45 years in the environmental health engineering field, Associate Professor of Health Sciences at Indiana University School of Medicine 1952-1975." . . . From **Roger H. Williams** comes the cryptic note, "Lois and I have returned to Hingham and plan to take it easy." . . . From the latest Alumni Register, he was at St. Louis University, so apparently that is where he is returning "from." . . . **Bob Ebenbach** is still at it though and writes, "No particular news. Still single. Still working at consulting engineering on rapid transit car structural problems. Skied at Sun Valley this spring; looking forward to some sailing this summer, and to a gall bladder excision in the fall." I'm not sure the latter is something to exactly "look forward to." By the time this is in print, it should be past tense and I hope everything went all right. . . . **Harry Hallas** notes, "Retired as Director of Plant Operations of the Brookline Hospital in March, 1975." Since the envelope had an East Sandwich postmark, he apparently is an addition to our Cape Cod contingent. . . . The final retirement note is from **Ralph Ranger** who says, "After 39 years with G.T.E. Sylvania I retired last August (1975). Prior to retiring I was Product Sales Manager at Exeter, N.H., specializing in lamp filaments, quartz tubing, plus other lamp, television and radio heaters. During the past several years I have had the opportunity on business calls to visit most European and South American countries."

Just to show why they have horse races, here are two varying viewpoints. **Phil Kron** writes, "We've sold our home in Boca Raton, Fla., and moved back to the Rochester, N.Y., area. Florida was just too hot and humid for us to spend so much time there. I'll miss the golf in the winter but we may go back for a short visit in the cold weather. Best regards to all." . . . The other side of the coin comes from **Warren Kunz** who says, "Just returned from a nine-month cruise in our ketch. We found the Abaco Islands in the Bahamas delightful and no longer like the chill in the air in Massachusetts. Plans are forming to enjoy the warmer areas more." As one who agrees wholeheartedly with Phil and knows that Warren lives in just about the same climate as we have on the Cape, I can only regard Warren as a backslider with weakening moral fibers. Of course if I had a cruising ketch, this harsh judgment might soften some.

I have a letter from **George Bull** about a trip to Russia which I'll save for next time. You might want to note from below that he has a new address. — **Robert M. Franklin**, Secretary, Satucket Rd., Brewster, Mass. 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Chevy Chase, Md. 20015

35

Leo Beckwith has been after me to thank those who attended our 40th Reunion and signed the card that was sent to him. He was delighted with the thought, the individual phone calls, and the cards he received.

On June 4 we had a mini-reunion at the Faculty Club attended by the following: **Ned Collins** and Florence Driscoll, **Leo** and Betty **Beckwith**, Ellen and **Chet Bond**, Rhoda and **Bernie Nelson**, Agnes and **George Forsburg**, **Rufus Applegarth**, Ruth and **Al Johnson**, Sarah and **Phoenix Dangel**, Catharine and **Dick Jarrell**, Ginny and **John Taplin**, Jane and **Peter Grant**, Doreen and **Allan Mowatt**, and **Gerry Golden**. Bernie Nelson and Ned Collins organized the cocktail hour and dinner, and sound movies that **Ed Taubman** took at our 40th were shown. Leo, our Class Agent, announced that all gifts made to M.I.T. between now and our 50th reunion would be credited toward our 50th reunion gift. Bernie seconded by others asked our support of the Historical Collections in our gifts.

Lou Pflanz writes: "My daughter Pamela graduated from Colorado State this May, '76 and as she loves the southwest is seeking employment therein. Son David (18) will be attending Wentworth Institute this fall. He appears to be headed towards building construction management."

From **Frank Hatch** in Palo Alto: "Made a trip last month to New Jersey and the D.C. area where our daughter and her husband live plus our only grandson so far. One of these days I would like to include New England on one of our tours." Frank and **Ham Dow** have gotten together on one another's golf courses since Frank wrote. Ham reports that Frank has retired from Shell for whom he worked for 39 years, has two daughters same age as his own. . . . **Bob Forster** writes from Stockholm: I have been doing the usual amount of traveling to Helsinki, Oslo, Copenhagen, Brussels and twice to Zurich. After a while it gets to be like just another trip. We will be home about Thanksgiving, and will probably be around Wellesley for a month, and then go to San Diego. This will be home base for Rob and Sharon after he graduates from War College. There is some possibility I will be back over here next year."

Alumni Fund News adds the following to our list of retirees: **Alex Hamilton** from Eastman Kodak on Feb. 1; **Edward Rees** from Texas Instruments in May, 1975, to become Chief Engineer for McCormack Corp. of Dallas in April, 1976; **Vince Fopiano** from Raytheon Equipment Development Labs after 34 years — he has built a new house in Ogunquit, Maine, and is now a converted Maniac (P.O. Box 355); **W. Earl Peterson** from the Federal Aviation Administration three years ago — he's enjoying life in Austin, Tex. with golf, bowling, bridge, amateur radio and travel; **Darrell Root**, a senior vice president of Camp, Dresser & McKee, Inc., Boston environmental engineers, retired after 25 years — he will continue to consult from his home in Winchester, Mass.

From **John Alden**: "My wife Anna is quite busy with her Simmons, church and other activities; we go birding often during spring migration; play a bit of bridge; get out in our canoe on good days. I helped to write the book, *The Central Mass*, published by Boston and Maine Historical Society." . . . **Lars Ekwurzel** writes: "Six grandchildren; wife JimmieJean is Co-Opera Chairperson of National Federation of Music Clubs; in addition to my Market 100 chores I am now handling regional sales for Technorite, Inc., selling learning systems to engineering schools everywhere." . . . **Maxwell P. Lewitus** notes: "We are semi-retired on Martha's Vineyard where I practice dentistry from May to October. We have a house in Guadalajara, Mexico, where we live from October to May." . . . **Jack Holley** writes: "Opened a beauty salon, the Nora-ly Beauty Box, last October. Two of my associates in the electronics world did this so I'm trying, too. Hope to be in the black soon. This is an interesting and stimulating activity and I recommend it highly, especially to older types." . . . **Manson Benedict** of Weston, Mass., who received his Ph.D. with us

has been selected to receive the nation's highest award for scientific achievement and was presented the Medal of Science by President Ford at White House Ceremonies. . . . Priscilla and **Jack Colby** stopped at the Nelson's on the Cape en route to New Hampshire and Maine. He advised that Lars Ekwurzel has agreed to work with him in keeping in touch with the growing number of our former classmates who are now living in Florida.

I am sorry to report the death of three more '35ers; **Howard Bernhardt** and **Fred Bensin** died on February 1, 1976; and **George Gales** (Glaskaws) died in late July, 1976. I extend our deepest sympathy to the surviving members of their families in Moorestown, N.J., Melville, N.Y., and Quincy, Mass., respectively. **George Forsburg** was kind enough to send me the news about George.

Some tidbits from the Golf Tournament: lowest round so far has been made by **Bill Bates**, the current champion, who had an 86 with a 28 handicap for a net 58. Twice **Fran Muldowney** has hosted '35er foursomes at his course in New Seabury; the first one involved Bernie Nelson, **Hank King** and myself and the other was with Ned Collins, **Chet Bond** and myself. At this stage we are in the quarter finals and we should know who the 1976 champion is by next time. Please write. — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

36

Our 40th Reunion brought out 58 members of the class, 42 spouses, and various offspring, either at M.I.T. or Jug End in the Berkshires or both. Seen or recorded were **Angevine, Assmann, Jim Baker, Beckwith, Birdsall, Borden, Carota, Carr, Chapper, Cohen, Cooperstein, Crummey, Dashefsky, Denton, Devereux, Dobrin, Easton, Emilio, Essley, Estabrook, Fingerle, Gilman, Grossman, Halfmann, Halloran, Hittl, Henry Johnson, Stan Johnson, Kanters, Kimball, Kramer, Krey, Mac Adam, McGrath, Mackro, McMahon, Moustakis, Mullen, Musschoot, Nyhen, O'Neil, Ortynsky, Osgood, Patterson, Perkins, Larry Peterson, Phillips, Reday, Elliott Robinson, Shainin, Terry, Thornton, Tremaglio, Viola, Webb, Weinert, Werblin** and **Zietlow**. I trust I have not omitted anyone, but it was very hard to make sure that I saw everybody in the general confusion in Cambridge. If you were there and not counted, please let me know.

Highlights of Alumni Day for '36ers included the presentation of our class gift, accompanied by fife and drum in approved bicentennial style. That morning, through the efforts of **Frank Phillips**, a four-oared shell took to the river. Weighing in at perhaps somewhat more than the original 150 lb. each of our sophomore year, the four oarsmen put on a good show, although no records were broken. At stroke was Frank Phillips, with **Slim Beckwith** at 3; **Henry Johnson**, 2; **Al Whitcomb**, 1; and **Larry Kanters**, cox.

At the class meeting held on Sunday, June 5, there were 37 members present. **Ed Dashefsky** reported that our class gift of $481,000 had been contributed by 262 members — 67 per cent. All officers and class agents were re-elected: President, **Anton J. Hittl**; Vice President, **Henry McGrath**; Treasurer, **Eli Grossman**; Secretary, **Alice Kimball**; Class Agents: West, **Henry Lippitt**; East, **Elliott Robinson**. It was pointed out that Scholarship Funds at the Institute have been set up in memory of Robert Leventhal and W.W. Garth, Jr. Gifts to M.I.T. may be designated to these funds. It was voted to have a 45th Reunion and **Fletch Thornton** agreed to chair the committee. It was also voted to put together a class report for this reunion and **Laddie Reday** is chairman for that effort. It was felt that information on what members like to do, what their interests are, and what their retirement plans are, would be appropriate for such a report. You will hear more about it soon.

I am sorry to report the death of **Edward Stritter**, after a long illness, on May 6. He had worked on rubber and plastic development with Boston Woven Hose and Rubber Co., Chase and Sons, Inc., and the Plymouth Rubber Co. He was a longtime member of the Appalachian Mountain Club. To his widow and family, our sympathy.

If you read these notes prior to the 30th of October and can find your way to northern Connecticut on that day, your Secretary and other members of the class hope you will join us for a "mini-reunion." So note the date — Saturday, October 30 — and plan to travel to Hartland Pond. You will be welcome from 11 a.m. on. — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, Conn. 06091

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Roger Wingate, Senior Vice President of Liberty Mutual Insurance Co., was elected to the Board of Directors at the company's annual meeting. . . . **Charles E. Reed** has been elected to the Board of Trustees of the University of Bridgeport for a three-year term. He is senior vice president for corporate strategic planning and studies of the General Electric. . . . **Richard Lamphere** and his wife Alice are at their summer home, Villula, on Lake Bomoseen, Vt. . . . **Ed Hobson** is President of Aladdin Synergetics, Nashville, Tenn., and is still commuting to his home in New Jersey. . . . **Frank D. Lewis** has a son, Peter, who is a member of the class of 1975 and is now a graduate student of Yale.

Our list of retirees is growing. **Lawrence G. Cyr** reports he is retired and **William McHugh** has retired from the Massachusetts Department of Public Health and the Massachusetts Hospital for Crippled Children. . . . **Leon Strauss** is also retired and dabbling in real estate, traveling and enjoying San Francisco. — **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Lester Klashman**, Assistant Secretary, 198 Maple St., Malden, Mass. 02148

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Cliff Nelson sent a note from Maine about a trip Jane and he took last June. "I was invited to give a talk at an international conference on Modelling of the Cardiac Electric Field in Bratislava, Czechoslovakia. The conference was held in the Smolenice Castle and was sponsored by the Slovak Academy of Science." From Bratislava they took a hydrofoil to Budapest, on the Danube River. From Budapest they went to Vienna and then to London for a couple of days to visit friends. Cliff would be interested in hearing from any classmates who are ham radio operators. His call is W1IDA.

William G. Guindon received one of Boston College's Presidential Bicentennial Medals on June 11, 1976. He represented the Jesuit School of Theology at the Biennial Assembly of the Association of Theological Schools in Boston in June. . . . **Richard C. DeLong** retired permanently from industrial chemical research in 1971 and moved from Buffalo to 400 acres out in Union Township, Huntington County. "It took a little while to realize just how much there is to do out here. It is a very full and satisfying life."

David B. Pearlmutter is a chemistry teacher at Chelsea Senior High School, Chelsea, Mass. . . . **Allen R. Cherry** is Senior Research Technologist in carbon fibers, with Carbon Products Division of Union Carbide Corp., Parma, Ohio. . . . **Norm Leventhal**, Class President, was recently elected to the Executive Council of the American Jewish Historical Society.

Wesley E. Gwatkin was appointed Vice President in the Government Products Division as part of the overall reorganization and restructuring of Pratt & Whitney Aircraft Group. Wes, most recently chief of engineering operations at P.&W.A.'s Florida plant, is responsible for a wide variety of supporting activities, including shop and test operations, materials laboratories, quality assurance, purchasing, and plant construction and maintenance work.

Lester Kornblith was named a Fellow of the American Nuclear Society. Les is a member of the Atomic Safety and Licensing Board Panel, U.S. Nuclear Regulatory Commission, Washington, DC. His duties encompass a broad knowledge of nuclear safety: reactor design and construction, operation of reactors and other nuclear facilities, and radiological and environmental protection. Formerly he was on the staff of the now disbanded Atomic Energy Commission and also with the General Electric Co.

The National Academy of Engineering elected two members of the class to membership: **Eric Reissner**, University of California at San Diego, for contributions in applied mechanics and mathematics, especially in the application of these to problems associated with determining the strength and stability of aircraft structures; **Reinhardt Schuhmann, Jr.**, Purdue University, for contributions to the science of extractive metallurgy and applications to process analysis and design — **A.L. Bruneau, Jr.**, Secretary, Hurdman and Cranstoun, 140 Broadway, New York, N.Y. 10005

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Leo Weiss, stimulated by **Hewitt Phillips**' comments in these notes, wrote a four-page letter to list some of his claims to fame. One son, Steven, earned his doctorate and is associated with the computer industry. Another son, Scott, is 16 and is associated with the transportation industry, such association being described by the dad as "the almost-daily dissection of a 1968 Buick convertible given him by his sister." The sister is named Robin and she works with Congress in Washington, but so far she has not reported to her dad whether or not U.S.A. taxpayers should be grateful they don't get all the government they pay for. Another son, Randy, does earth sciences research for a mining company. Milly is the busy wife and mother of this fine family and she has earned some outside fame with her Sumi-E painting which is a kind of oriental brush painting. Leo didn't write much about himself except to say he enjoys lifelong hobbies (such as building and operating radio-controlled model gliding planes) and he has founded American Scientific Enterprise, Inc., to develop commerical applications of new ideas.

Bill Bassett continues engineering work at Bethlehem Steel and vacations at Cape Cod and ski resorts. The Bassetts have three sons, the oldest of whom attends Exeter. . . . **John Dodge**'s career has included 22 years with the Air Force and current residence in Philadelphia where he is active in G.E.'s reentry and environmental systems division. . . . **Percy Hurt** has retired and he raises oranges on a 20-acre grove. . . . **Joe Neuendorffer** does operations research for the Navy at Norfolk and is the proud grandfather of four. . . . **Dick Robbins'** career has included 17 years in structural and civil design for steel plants and refineries, followed by 20 years in engineering for the Air Force. Dick and Rosemary have three children, two sons who earned master's degrees and a daughter who programs computers.

Fred Holloway is Vice President for Science and Technology at Exxon, and was recently re-elected for a one-year term on the Council of the National Academy of Engineering. . . . **George Cremer** was named the discoverer of unique tiny hollow metal spheres having potential use to harness fusion energy and make it useful for man's needs and pleasures. The report states one thimblefull of George's micro-spheres contains energy equivalent to that found in three railroad tank cars of gasoline. One might imagine that, some years hence, a family starting its annual vacation, might drive up to a service station (which no longer would offer gasoline) and the driver might say to the attendant: "Fillerup with one gram of George's micro-spheres."

John Renshaw and Lolita have returned from honeymooning in the South Pacific at Bora Bora and make their home in the San Francisco area. John continues to be active in investment counseling and, to extend his diversifications, he oversees tree farming in Arkansas and some gold placer mining in Alaska. . . . **Pete Bernays** writes

Sinsheimer's Inquiries into Inquiry

Are the powers given us by modern science and technology so great that their use for further scientific research may place mankind in jeopardy? "Is inquiry itself to be exempt from inquiry?" asks Robert L. Sinsheimer, '41, Chairman of the Division of Biology at the California Institute of Technology.

Dr. Sinsheimer's answer is that "the stage of history does change," that the "art of inquiry is now mature and deeply penetrating," and that "we should not trust ourselves to civilize its course."

Some examples, which he cites in Caltech's *Engineering and Science* (May-June, 1976):

— We should not do experiments that "involuntarily make of *man* a means rather than an end" — a reference to the restraints implied by the ethics of human experimentation.

— We should not do research where serious physical or biological hazard is at risk — for examples, atmospheric nuclear testing and (perhaps) recombinant DNA *(see pages 10-12).*

— We should not do research if its dollar cost is vastly greater than the value of any possible benefit which could accrue. A manned landing on Mars would be such a case, thinks Dr. Sinsheimer.

— We should not undertake inquiries which "carry within themselves the seeds of what I would call label social hazard or, perhaps, just plain mischief," writes Dr. simple means for predetermining the sex of children.

Science does indeed have new responsibilities, thinks Dr. Sinsheimer: "We need somehow to find a way to doubly responsible, both to mankind and to science as one of man's finest creations." — *J.M.*

from Columbus, Ohio, that he manages in the abstract. Having excited curiosity with such an introduction, Pete goes on to say his employer is the American Chemical Society and he works with its chemical abstracts division. Pete's daughter, Linda, will be teaching in New York City, and another daughter, Sally, will be a senior at William Smith College. His son, Michael, will be a junior at Ohio State. Pete has been active in Kiwanis, scouting, and the M.I.T. Educational Council, and he and his wife enjoy church work and the American Field Service.

We have been saddened by news of the deaths of **Sam Abbott** and **Henry Knippenberg III**.

Sam Abbott was President of Hillsborough Mills, Abbott Machine Co., Wilton Top Co., and Abbott Worsted Mills. He was active in community and trade association affairs and, in 1960, was a co-winner of the New England Pro-Am golf tournament.

Henry Knippenberg was a management consultant and a member of the Third Church of Christ Scientist at Columbus, Ohio.

During July, Hilda and I were in San Francisco where we joined some 10,000 barbershoppers who had come together to do their annual doo-wah thing. While there, we visited Charles Godfrey, '40, and his lovely wife, Regina, at their home near the campus at Berkeley. Charlie continues doing creative things at Physics International and he is concerned with the peaceful applications of nuclear energy. We would suggest that Charlie collaborate with George Cremer to optimize United States energy use. A by-product of their future success might be to give the class of '40 a new reason to erase the chagrin of its defeat suffered as a result of Field Day Contests during October, 1936. — **Hal Seykota**, Secretary, 2561 Via Viesta, La Jolla, Calif. 92037

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Appreciated: I recently received a copy of a memorial booklet sent widows of alumni deceased during the past year. Included were the names of our deceased classmates and the text of the memorial service held at M.I.T. Chapel on Technology Day, June 4. The words of condolence and prayer were comforting and inspiring. We all thank the Alumni Association for this gesture.

Notes on the Backs of Alumni Envelopes: **William B. Singleton**, this year's chairman of the Baton Rouge chapter of the A.I.A.'s America 200 Committee, directed production of an exhibit for the A.I.A. meeting in Philadelphia. The exhibit displayed plans of Baton Rouge at 50-year intervals from 1776 to 1976. . . . **Robert W. McKinley**, who has just completed his term as director of A.S.T.M., sent his greetings. . . , **Clem Burnap** says he has been busy for Kaiser Engineers from India to Australia and from the Ivory Coast to Alaska in a variety of projects including iron and steel, uranium, and chemical fertilizer production.

Not in the Mold: **Roger F. Mather** is now teaching, researching, and writing on the art of flute playing. He teaches his instrument at the University of Iowa as well. . . . **Alfred E. Castle**, who left Eastman Kodak in 1969, is pleased with his new book, *Regional Cooking in China,* published by 101 Productions, a new San Francisco publisher. . . . **Robert S. Nelson** says without equivocation, "TM, transcendental meditation . . . is the most important happening for mankind in centuries. . . . If you care for yourself and civilization, as we too often only profess, learn TM."

Promotion: **Charles F. Fitter**, now living in Penfield, N.Y., is assistant to the general manager (Asian, African and Australasian Region) of Eastman Kodak.

Medal: The 1975 Harleston Parker Medal for excellence in architecture goes to **I.M. Pei** and partners for their design of the Christian Science Center in Boston.

Retirees: **Millard F. Dowell** and wife are much traveled since retirement in 1969. It was Greece last year and South America this year. . . . **Kendall C. Valentine** has retired from Pratt and Whitney aircraft.

Executive Suite: **William Kather** of Chicago has led his firm, William Kather Associates, up a growth curve of more than 30 per cent per year since 1970. The firm offers a range of marketing and corporate development services. He is just as proud of his four grandchildren. . . . **Russell Haden, Jr.** is now President of Taylor Industries, which makes and sells carpet installation supplies, from plants in City of Industry, California, and Atlanta. He and his associates acquired the company just this April.

Random Roll Call Scores A Hit: Among those selected at random from our roster we have **Amos E. Joel, Jr.**, who writes: "What a coincidence that my name should come up in your . . . lottery at the same time I have something to report." Indeed he has. A Bell Labs man since 1940, Joel has added to a long list of awards the Alexander Graham Bell Medal for 1976. Shared with two colleagues, the award, including a $10,000 honorarium, is given for their contributions to the development and introduction of Electronic Switching Systems, the main ingredient for today's nationwide communications network. Joel is known for his development of the Traffic Service Position System and the Automatic Intercept System — both widely used in the Bell System.

Hail and Farewell!: **Alton J. Wadman**, of Silver Springs, Md., died in April. He is survived by his wife. . . . **Joshua B. Feldman**, head of Draper Laboratory's Administration and Facilities, died on July 2. He is survived by his wife, Maureen, and three children. — **Frank A. Yett**, Secretary, 254 S. Euclid Ave., Pasadena, Calif. 91101

41

You missed a good one. The 35th Reunion of the Class of '41 was a great event, thanks to **Leona (Norman) Zarsky**, **Ed Marden**, the Reunion Committee, and the participants. Sixty per cent came with wives. To answer a recent *New York Times* headline, "Is There Life After College?" our 35th proved there is. The years have treated most of us well. War, postwar baby boom, careers, children's education — all have been spanned in these 35 years. Many of us are now looking forward to a slower pace and more travel. To those of you who didn't make our Reunion, we missed you and wished you could have been there.

Here's the latest news of **Ralph Landau**: his $7.5 million donation to M.I.T., and the dedication of the new Chemical Engineering building in his name. Ralph was also re-elected to a three year term on the Council of the National Academy of Engineering. . . . **Courtland Perkins** is president of the Academy. . . . Of the three life members of the M.I.T. Corporation named this year, two are from our Class: **Carl M. Mueller**, Managing Partner of the investment firm Loeb, Rhoades & Company; and **Ralph Landau**. . . . **Charlie King** informs us he has finished his assignment as Director of Engineering for the Apollo-Soyuz mission. He learned some Russian in the process. Now he is Director of Systems Engineering for Space Transportation Systems operations (the "airline" that will fly the space shuttle to make space flight cheap, he says).

Ray Ketchledge has been awarded the Alexander Graham Bell Medal of the I.E.E.E. for 1976. **Louise (Houssiere) Herrington**, who is a consulting geologist in the gas and oil area, says that with the children "just about finished with school" more time is available for travel. Her son, Patrick, is graduating from Tulane Medical School and her daughter is graduating in geology. . . . **Henry Arnold**, Director of the Office of Science and Technology for the Agency for International Development will participate in Project: Knowledge 2000. He, and 350 leaders from a variety of fields in the United States and other countries, will attend a series of three-day forums. The goal is to stimulate thinking and discussion about the generation, transmission, and uses of knowledge in the years to come. After each forum, videotapes and guides for group discussion will be distributed to communities throughout the nation.

We have two retirements to report: that of **Brandon Rightmire**, who received his Sc.D. in 1941 and has been Professor of Mechanical Engi-

neering of M.I.T. since 1942; and that of **Jim Creighton**, who has been General Manager at Bethlehem Steel's Burns Harbor, Indiana, plant. Jim started there as a summer employee in 1937. He and his wife will be moving to Cushing, Maine. . . . We have a newspaper article relating the death of **Richard Sawler** as a result of a two-alarm fire that swept the family home in Melrose, Mass. Our condolences to his family and our wishes that his wife, daughter and son who were also in the fire have fully recovered. — **Henry Avery**, Secretary, U.S.S. Chemicals, 2863 — 600 Grant St., Pittsburgh, Penn. 15230

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Headline news this month is that **Ed Vetter** who retired as Executive Vice President of Texas Instruments last November has been elected President of the M.I.T. Alumni Association. He also was appointed Under-Secretary of Commerce by President Ford on June 23. If memory serves, I believe that Ed is the second M.I.T. alumnus to be in the Commerce Department at the Secretary level; the first was Herb Holloman of the Class of 1940. . . . **Ray Ketchledge** has recieved the first Alexander Graham Bell medal from the I.E.E.E. This award was established to commemorate the Centennial of Bell's invention of the telephone and is one of the I.E.E.E.'s most valued awards. Ray is Executive Director of the Ocean Systems Division at Bell Labs in Whippany, N.J. . . . A short note and a very early sales pitch for the M.I.T. Fiesta in Mexico City from **Jon Noyes**. He writes "Kay and I attended once again the M.I.T. Fiesta in Mexico City. We recommend and expect it to be even better next March after devaluation of the peso." Jon still enjoys hunting, fishing, flying, ranching, tennis — and work. . . . **Charlie Estes** who was Acting Director of the Motorola Corporate Research Lab has been transfered back to the Government Electronics Division. His new post is Manager of Military Display. . . . **Bob Breckenridge** was the subject of a whole column in the *Chemung Valley Reporter* about local scientists. Since he was born and raised on Jamestown Island, Bob surely qualifies. He was Chief of the National Bureau of Standards Solid Physics Section and later worked with the U.S. Navy Office of Naval Research as head of its physics branch. In 1955 he transferred back to industry as Director of Research for National Carbon and later as Director of the U.C.C. Research Institute. Though he retired in 1973 and now lives in California, I am sure he is still fooling around with the dielectric properties of crystals. . . . **John Whitman** writes simply that he is still in the air defense business (he did not say where!). His oldest son graduated from Harvard last June. John, some more detail will be appreciated. You've got us awfully curious!

Manuel Lukoff writes that he has been more or less in engineering since graduation and "other than the solution of an occasional challenging problem, I cannot report any startling success." Thanks for that one anyway. Your secretary is always appreciative of any kind of news and it doesn't necessarily have to be "startling successes!" . . . **Bob Howard** came through with his usual long and interesting letter. He has made the transition back to New England successfully. Daughter Angelika received her Ph.D. in Chemistry from Cornell last November; Lourana returned from her Peace Corps mission in Ghana and son Robert got married in Huntsville, Ala., in March.

Steve Stephanou is Professor of Systems Technology at the University of Southern California and reports that he had a pleasant visit with **Bob Keating** at the recent Los Angles area Alumni meeting. Bob is still Manager of Operations Analysis at the Susquehanna Corporation in Los Angeles. . . . Got another big brochure from Jyoti, Ltd.; **Nanu Amin**'s company is now able to accept orders for pumps up to 800,000 liters per minute. For you who are not that hep in metric yet — that is 2,560,000 gallons per hour!

Now to our retiree's corner. **Harry Maynard** who retired as a U.S. Navy Captain in 1964 has re-retired as General Manager of the Bellevue (Washington) Chamber of Commerce. He is set up in business as a consulting engineer in Bellevue. His daughter, Ellen, is a Lieutenant in the Navy Nurse Corps at Bethesda Navy Medical Center. . . . **John Rothery** has retired from Arthur D. Little in Cambridge and moved to Marblehead permanently. . . . **Cart Laffoon** retired as Senior Vice President of the San Diego Gas and Electric Co. He has established a consulting engineering firm to serve the energy industry in El Cajon, Calif. . . . Finally a very high class retirement. **Loren Brunner** who retired in 1964 after a 30 year career in the U.S. Coast Guard has re-retired from the faculty of Purdue University and was appointed a Professor Emeritus there. Loren was elected by students and faculty as the outstanding undergraduate teacher at the Purdue campus in Hammond, Ind., in 1968. We are a little late acknowledging that fine honor, but better late then never. Let's have some more news. — **L. K. Rosett**, Secretary, 191 Albemarle Rd., White Plains, N.Y. 10605

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The reason I missed writing the class notes for the past two or three issues escapes me for the moment. I do recall, however, that I was married in Santa Barbara on May 9 to Mrs. George T. Chadwell of that fair city, widow of Col. Chadwell, U.S.A.F., and Margot and I have been rather busy since then. During the daylight hours I am continuing my preparation work of the defenses to what has now become $60 million in claims and lawsuits against the State of Connecticut, arising out of the construction of the University of Connecticut Health Center in Farmington. The trial could take well over three years.

During the recess I accumulated lots of good stuff, including a letter from **Jack Kelly**, who endorsed the idea of having our 35th Reunion aboard Oivind Lorentzen's Flagship Cruise, the *Kungshold*. Jack also wrote, "Our mutual classmate, **Jack Gardner**, who has been with various Exxon affiliates over the years, is still domiciled in London where he is department manager of manufacturing for Esso Africa, Inc. Jack and Jane are still living in Kingswood, Surrey, England, about 20 miles south of London. Their children are spread all over; one or two with them in England, the others in the U.S.A. My wife, Lois, had a long chat with Jane Gardner during our recent five day trip to London, but unfortunately I did not get to see Jack during that visit." Jack then described another Butterworth product, called SCAMP hull cleaning equipment, which is a little remote-controlled device which scoots back and forth along a ship's hull, brushing away all the stuff which slows down speed. These are for big vessels, gentlemen, not for your 30 foot sloops. He said that his 12 franchise operators cleaned over 500 vessels last year with these profit-making gadgets.

Herbert Shivek was elected to the board of directors of New England Sinai Hospital, a chronic disease and rehabilitation hospital serving New England. He is president of Serve-O-Lift Corp.; a Brookline, Mass., town meeting member and chairman of their Planning Board. . . . **Charlie Hathaway**, former president of Torin Corp., has become vice president and general manager of the Bristol Brass Corporation's Accurate Forging Corp. in Connecticut. . . . **Ira Cruckshank** has been appointed vice president of research and product engineering, for Stanley Tools, New Britain, Conn. Bud has been with Stanley for many years in managerial work, and recently received his master's degree in Business Administration from the University of Hartford.

At the I.E.E.E. annual meeting in Boston last May, **John Linvill** was honored with a citation for "leadership as a teacher, author, and administrator, and for contributions in solid-state electronics and technology." . . . **Donald C. Berkey,** who received his masters degree with our class, was elected vice president of the General Electric Company last Spring. He is vice president and general manager of their Energy Systems and Technology Division, in Fairfield, Conn. . . . **Charles E. Columbus**, a retired Coast Guard officer, who joined the Purdue University faculty in 1965, received the honorary appointment to the rank of professor emeritus upon his retirement from his professorship there.

Pete von Wiesenthal wrote that he is President of Heat Research Corp., a subsidiary of Pullman, engaged in design and construction of furnaces and specialized heat transfer equipment for the oil and petro-chemical industries, particularly ammonia plants and ethylene. "Although headquarters are in New York City," Pete wrote, "I spend a great deal of time in Houston and points around the world. My daughter, Andrea, is at Sweet Briar College and my son, Peter Christian, is at Clarkson College of Technology. We all take our spare minutes for riding, skiing and sailing." . . . **John W. McDonough** is living in Memphis, Tenn., where he is vice president and general manager of Moore-Memphis, a division of Moore-Oregon, manufacturers of dry kilns and lumber handling equipment. He wrote that business is somewhat better for lumbermen, and so much the better for his company. . . . A note from **Malcolm Walker** advises us that his son, David, graduated from M.I.T. last May with a B.S. in electrical engineering and computer sciences. Long active in Braintree, Mass., civic and business affairs, Malcolm continues as a member of the Braintree Historical Commission, and is now a Trustee and member of the Board of Investment of the Braintree Savings Bank.

One of our other bankers, **Gene Morrison**, wrote that he acquired a portable TV tape recorder, which he is using to analyze his golf swing and putting, hoping to drop his handicap from six to two. He talked to **Bill Terry** in Houston recently, who sees Pete Wiesenthal from time to time, according to Gene, when Pete visits Houston. Gene wrote that only one of four children is left in college, and that he's looking forward to the 35th Reunion. . . . **Charlie Chubb** wrote, "I am still working as Senior Vice President for Dynell Electronics Corp. on Long Island, N.Y., designing radars and Omega navigation receivers. Most of our radar work is for the Navy and Air Force, but the Omega receivers are also used in commercial planes and ships. . . . **Ed Epremian** wrote that he has taken early retirement from Union Carbide's Metals Division where he was Director of Business Development, to accept an appointment as Executive Director of the Commission on Sociotechnical Systems of the National Academy of Sciences in Washington, D.C.

Tony DelValle called from New York City early in June, where he was attending the opening of another branch of Puerto Rico's largest bank, Banco Publico, of which he is a director. He said that daughter Carmen is now in college, in the States. . . . **Iz Lenzer** telephoned from Mt. Vernon, New York, to tell me he ran into **Jim Hoey** at a college graduation in upstate New York, where his step-son and Jim's daughter, Mary Jane, both received degrees. I called Jim recently, at his home in Chatham, on Cape Cod, and he said that he's heard from Class President **Ken Warden**, who has a place in Eastham, and that we'll be getting together in September, after Labor Day, for a 35th Reunion conference. It has been a great summer for me, including a couple of business trips to the Big Apple, which my bride, Margot, enjoys thoroughly. I look forward to more calls and letters. — **Richard M. Feingold**, Secretary, 779 Prospect Ave., West Hartford, Conn. 06105

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We are still recuperating from the garden wedding and reception for our daughter, Amy, to Erik G. Mitchell, a local builder. We were delighted that so many of you took the time to pen a note to us at the time of your annual contribution to the Alumni Fund. Please forgive us if we don't use all of the material this month.

We attended the Alumni Day luncheon in Rockwell Cage with **Frank Carroll**, **John Taft**, and **Robert J. Horn, Jr.** Robert Bliss ('48) and Robert Cowen ('49) were also at our table. **Edgar C.**

Ahlberg, **John B. Gardner**, **Robert V. Laney**, **Edgar J. Moor**, and **Joseph J. Snyder** were also on the list of attendees but our paths never crossed. On Alumni Day we sold a Class of '44 bread tray. Later we received an order by mail for two more. It is not too late to order one or more of these trays for holiday gift giving. They are available through us with all profits going to our class treasury.

Bernard Rabinowitz, President of Atlantic Chemical Corp., Nutley, N.J., wrote of his family: his wife, Ann, is active in local community affairs and is now a member of the Nutley Board of Education; their son, Dan, and his wife, Ann, are graduates of Yale Law School and working and practicing in the legal field; daughter, Rebecca, received her degree from George Warren Brown Graduate School of Social Work in St. Louis and is now working on alcoholism programs; daughter, Sarah, is a junior at Connecticut College in art and government; and son, John, an oboist par excellence, is entering Nutley High School. What a family to be proud of and how fortunate we all are of the benefits to be received from their chosen endeavors.

Robert M. Isaacs wrote that he had nothing new to report, and that his search for news of the Class was fruitless. . . . **Paul Heilman** was pleased to see that notes were appearing again in the *Review*. He adds that his daughter is finishing at the University of Delaware and that his son is just starting at Georgia Tech as an electrical engineer.

Bob Clarke spent an evening with us in May following a three-day conference in Boston for selected A.T.&T. personnel. Bob told us that his wife Mary Lou is a purchaser in the Cresskill, N.J., school system; his son Bruce is at Rutgers; his son Bobby is at the University of Delaware; and his daughter Linda is in high school. . . . **Kay (Adams) Kulmala** writes that she now has the best of both worlds, having taken over The Planning Services Group, Inc. (a planning consulting firm for whom she had worked for 20 years). She is operating the business from her home.

At this time of year we hope you are also enjoying the changing of the seasons along with its outdoor activities, including the many college and pro football games. — **Newton A. Teixeira**, Secretary, 92 Webster Park, West Newton, Mass. 02165 (617-332-7199)

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The 30th Reunion in June was a great success. Fifty-three classmates, their spouses, and 45 children, moved in on Cambridge one fine and sunny day. We wish the reunion could have been larger. Most of those who attended have been at every past reunion.

Some of the class came long distances: the **Alan Eagles** from California, the **Sigurdur Halldorsson** family from Iceland, with other attendees from Michigan, Ohio, Virginia, Florida, and the state of Washington. To those who didn't come, I must say you missed a wonderful time.

The activities began on Thursday, June 3, with people arriving at all times during the day. The 1976 Reunion was the largest in history and all of the dormitories were filled. The class of 1946 was fortunate enough to be housed for two days in the high-rise Fenway Cambridge Motor Inn, a short distance down the Charles from the Institute. The next day, we were moved to the dormitories vacated by older alumni, who moved to the Cape. Thursday's dinner was a buffet held at a very unusual location, the M.I.T. Historical Collections. **Bob Spoerl** gave a very funny and extremely involved report on the change. Busses took us to M.I.T. night at the Boston Pops, which was a grand evening indeed.

Friday was Technology Day '76, with breakfast at the Student Center, memorial service at the M.I.T. Chapel, luncheon in Rockwell Cage and three programs of seminars filling the afternoon. A cocktail hour and lobster dinner at the Fenway Cambridge Motor Hotel concluded the day.

Saturday, June 5, brought a class seminar on Career, Family, and Self Development with a focus on mid-life problems that we in the class are now facing. The meeting was open and informative; later we broke into small groups where we spoke more intimately of our problems with career changes and altered families as our children grow up and leave home. At noon we boarded busses to the Boston Pier, and cruised the harbor on the *S.S. Bostonian*. The busses returned us to the dorm where we prepared for a gala dinner dance at Burton House. More on reunion activities next issue.

Walter R. Milliken writes that he is now Advisor to the Commander of the Air University and Commandant of the Air War College, with specific interests in leadership, management subjects, and logistics. . . . **Edward J. Bacon** joined the Engineering Department of the U.S. Postal Service in 1975 and is engaged in programs to apply mechanization more effectively to the postal system. Edward's daughter, Ann, passed up M.I.T. for a swimming scholarship at the University of New Mexico. . . . **Jack Norton** writes his regrets on missing the reunion. He is still with G.E., the last four years in Greenville, S. C., with the Gas Turbine Division. He and his wife, Priscilla, are well and enjoying the slow, easy life down South. Jack reports his son, John, received his law degree at Boston University and is practicing law in Maryland. His daughter, Linda, is teaching high school English at Merritt Island, Fla. . . . **Robert S. Levine** is now Chief of Fire Research and Information at the National Bureau of Standards in Washington, D.C. . . . **Daniel M. Kelley** has been named Publisher of two McGraw-Hill medical publications, *The Physician & Sportsmedicine* and *Postgraduate Medicine*. Dan joined McGraw-Hill in 1947 as a technical book editor. Dan, his wife, and four daughters live in Chicago.

Until next time, the best to all. — **Russell K. Dostal**, Secretary, 18837 Palm Circle, Cleveland, Ohio

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I trust that all had a pleasant and productive summer. A clipping points out that **Huey Long**, with his 79-foot Ketch *Ondine*, did well in breaking the elapsed time record in the Cape Town to Rio Race. Further from the clipping services: **John Midney** has been named Assistant Secretary of Emhart Corp. and General Attorney of Emhart Industries Inc., a wholly-owned subsidiary. . . . **Paul Cook** has been elected a life member of the Corporation of M.I.T. He is President of Raychem Corp. in Menlo Park, Calif. . . . **Bob Creek** writes that he is still President of the school district and continues in the throes of its $30 million expansion. This past spring he spent time in Europe visiting his daughter in Vienna where she is studying the Lippizaner horses. This sounds intriguing as I wonder how that can be her full time vocation. He also visited Union Oil's discovery in offshore Scotland. At home he is fighting the dismemberment of the oil companies and points out that such action, if started, could happen to many of us.

Ray Hase recently returned from a month in Argentina and Brazil where he was conducting courses in underwater acoustics for the naval scientists of the respective countries. He was favorably impressed with the $2.00 steak dinners in Buenos Aires. . . . **Jack Greene** is another recent returnee from a six-month sojourn in Iran. He was consulting on Emergency Preparedness Planning for the Prime Minister and the Imperial Army's supreme staff. . . . **Bob St. John** was recently named Director, Quality and Process Technology, for Emery Industries, Inc., in Cincinnati, Ohio. . . . **Walt Kern** writes that he is still Chief Mechanical Engineer of Teradyne and playing a lot of tennis. He states that he has a vacation house at Hilton Head near a tennis club which is very interesting since we have been very seriously considering doing the same. There are about seven plantations on Hilton Head each having Tennis Clubs, as I recall, and I wonder in which the Kern's have located?

Drop a line. — **Dick O'Donnell,** Secretary, 28516 Lincoln, Bay Village, Ohio 44140

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Warren King has been organizing groups of business executives to probe the operating practices of state governments since 1963 when Governor James A. Rhodes of Ohio called Warren into Ohio. In the May, 1976 issue of *Reader's Digest* an article titled "They're Trimming the Fat from State Government" described how Warren and his Chicago-based consulting firm have been asked to coordinate management reviews of the governments in 20 states.

Warren and the Governor of Ohio drew up ground rules: It would not be sufficient to "borrow" executives one or two days a week. They would have to recruit the best talent in the State on a full-time basis, until the job was done. After Ohio businessmen studied every department of state government for three months, they presented 511 recommendations to save Ohio taxpayers $50 million a year. Governor Rhodes implemented nearly 75 per cent of the recommendations. Actual savings were $60 million which exceeded the estimate. To date Warren's consulting firm has coordinated reviews in 20 states, and at least three other states have instituted programs of their own. Warren lives in Chicago and I hope he'll be able to get to our 30th Reunion as I haven't seen him since about 1968.

Stan Shein has a management consulting firm that specilizes in providing data systems for management. During the past year he examined over a dozen data processing systems on service bureau, time-shared or in-house computers. Stan also writes a monthly newsletter for his firm.

Stan attended the cocktail party at McCormick Hall before Tech Nite at the Pops. About 100 people from '47, '48, and '49 attended. Some of the people I spoke to were Rose and **Leon LaFreniere**, Polly and **Nick Caldwell**, Tel and **Bob Sandman**, Nancy and **Don Noble**, Gloria and **Sonny Monosson**, Eleanor and **Harry Ottobrini**, **Stan Shein**, **Bob Bliss**, **Dick Harris** and his wife, and Ann and **Ken Brock**. Also, I spoke to **George Clifford** who has accepted being chairman of our 30th Reunion.

Tech Nite at the Pops was as usual a lively, exhilarating experience. The house was sold out and several classmates attended the party but all did not go to the Pops. On Friday the luncheon in Rockwell Cage was attended by a full table of classmates. Keenie and **Pete Richardson** sat next to Gloria and me. Pete is Director of Admissions at M.I.T. and Keenie works at the M.I.T. student center scheduling meeting facilities.

Harry Jones was also at our table. Harry is now in business for himself as a corporate development consultant and business broker. After 18 years and 16 completed acquisitions and divestitures for his employers, Harry decided to move to the other side of the negotiating table. Harry was elected Councilman and Deputy Mayor of Ridgewood, N.J., in May. Harry and Ann have one son, Craig, who is 13 years old.

Noa Spears was presented with a certificate of commendation by the Alumni Association. Noa was the Secretary-Treasurer of the M.I.T. Club of South Texas in 1975-1976, during a time that was pivotal in the development of the Club.

Denny McNear was elected President of Southern Pacific Transportation Co. Denny had been Vice President in charge of operations for the Company, which contributes the largest portion of the revenues of its parent, Southern Pacific Co.

George Brown wrote on June 30 which was the anniversary of his 12th year with American Motors and his fourth month as Executive Director of Vehicle Emissions and Safety. The first 140 months, of 144, were as General Service Manager which was always fascinating despite the occasional headaches. During the last four months working with the problems of over-zealous regulation the score is zero for fascination with the work and infinity for the headaches. George and Mary hope to attend the 30th Class Reunion and are looking forward to learning about the Reunion plans.

Eleanor and **Harry Ottobrini** with their children

Lisa and Mark visited Nancy and **Tom Pawel** during Fiesta week in San Antonio. Tom is a successful oil entrepreneur and just recently bought a ranch. Nancy is one of San Antonio's outstanding potters. Nancy and Tom have three beautiful daughters. . . . **Elliott M. Bates** writes that it has been a pleasant surprise to be working with **Stanley Palmer** at Colby in the course of their architectural pursuits.

I am finishing the writing of this news from our cottage at Birch Harbor, Maine. After three days of rain and wind related to Hurricane Belle the seas have subsided in intensity, but the waves are still surging into the rocky coast with the ferocity induced by the distant storm. Birch Harbor is about a mile in length and varies from 1,000 feet wide at the harbor mouth to 200 feet at the inner end. Outside our cottage the width is 800 feet and waves travel into the harbor without approaching either shore, many building to a height of three to five feet in the middle of the 800-foot line. A few feet farther into the harbor the water is calm. — **S. Martin Billett**, Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

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As I write, Greater Boston is enjoying cool, dry air which Sonya and I apparently brought back from our week of square dancing in Brevard, N. C. "Back home" since April 1, we are busy getting ready to move finally on September 1 from rented summer quarters in Concord to our own home a few miles across town at 77 Temple Road.

As usual, notes from Alumni Fund envelopes lead off the column, with a double dose of thanks to the dozen classmates who added information to contribution. **William G. Berresse** is Vice President, Manufacturing and Technical, for Consolidated Thermal Plastics Co. in Arlington Heights, Ill. . . . **Gene Eley** is "with Aerospace Corp., and still at Cape Canaveral after 25 years." . . . **William L. Glodt** has joined the honored ranks of amateur radio as WA3ZYS. He wonders how many other alumni are amateurs. . . . **Edward B. Hermann** is professor of occupational and environmental medicine at the University of Illinois School of Public Health. He received the Radebaugh award from Central States Water Pollution Control Association on May 20. . . . **Jerry Lewi** reports: "I have been very active in an attempt to incorporate the community into a locally governed city. After a two and a half year effort we have succeeded in placing a measure on the November ballot to be decided by the local voters." . . . **Gregory Lynes** reports that he remarried in November, 1975, and moved to Wellesley where his wife's children, three boys, are in public school. The eldest hopes to enter M.I.T. in 1978. "After a couple of years as consultant in management development, I am now searching for broader oppourtunity to improve management and professionalism of state and local government," Gregory writes.

Len Newton has been elected president of the newly formed M.I.T. Club of Princeton, after organizing the club as founding co-chairman. This M.I.T. club has nearly 100 members already and recently sponsored a two-part symposium on how scientists and engineers can get more political clout. Panelists at this command performance included Senator Case, Representative Fenwick, M.I.T. Professor Harvey Sapolsky, two Princeton University professors, and an official of the Brotherhood of Teamsters. Since his unsuccessful bid for U.S. Congress, Len is a marketing-communications consultant, specializing in electronic banking, energy and travel. . . . **Richmond Perley**'s son is studying chemical engineering in the M.I.T. class of 1977. . . . **Alan W. Postelthwaite** writes, "I joined the Magneto Hydrodynamics Division of ERDA in May to work on materials and components for MHD power generation. I am stationed in Washington." . . . **Robert Roberts** has just been appointed to the Structural and Seismic Advisory Committee for the Minnesota Building Codes. . . . **W.F. Wicks** is currently serving in the Naval Sea Systems Command, Navy Department, as Director, Underseas Warfare Systems. . . . **George E. Williams** reports a new position as Senior Vice President of Finance for Otis Elevator Co., New York City.

From Alumni Records we have information on the death of two classmates: **Wallace E. Hyde, Jr.**, of Moraga, Calif., died on June 5; **Dr. William K. Widger, Jr.,** of Meredith, New Hampshire, died suddenly of a heart attack on May 4. Our condolences to their relatives and friends.

The American Paint and Coatings Journal for May, 1976 contains a profile for **Richard G. Alexander**, President and Technical Director of Arvon Products Co., Inc. and President, Philadelphia Paint and Coatings Association. Alexander joined Arvon Products, a family owned business run by two equal partners, both now retired, in 1950, after working for one year as a control chemist at Yarnall Paint Company in Philadelphia. He was married in 1950 to Sandra Schaeffer and they have four children, Andrea, 24, Todd, 22, Abby, 20, and Jane, 18. They live in Elkins Park, Penn. Skiing and sailing are Alexander's favorite sports and he states his favorite hobbies to be painting, sculpture and photography. . . . *The New England Engineering Journal* for July, 1976 reports **Fletcher Eaton** as ESNE's new Vice President. Fletcher modestly explains his background and qualifications as being "a mechanical engineer at Polaroid with a B.A. from Colby College, a B.S. from M.I.T. and an M.S. from Northeastern University." The article goes on to state that Fletcher has also been the mainstay in the success and growth of the Massachusetts Engineering Counsel. "He has received the acclaim and plaudits of his fellow mechanical engineers for his outstanding achievements as the Chairman of the American Society of Mechanical Engineers, Boston Section." Fletcher is also the Estate Secretary of the Class of 1949. He and his wife Nell have two children, Daniel and Martha.

In citizens band (CB) terminology, **Herbert M. Federhen (IV)**, now a Colonel in the U.S. Army at the ARPA in Washington, is in the "rocking chair," having as a "front door" his father (III), with an M.I.T. degree in 1920, and as a "back door," his son (V) of the class of 1976. Except for the Roman numerals, all three have the same name. . . . **Theodore R. Madden** of Somerville, Professor of Geophysics and Graduate Registration Officer in the M.I.T. Department of Earth and Planetary Sciences, has been elected a Fellow of the American Geophysical Union. The rank of fellow, never held by more than three per cent of the entire A.G.U. membership, is awarded in recognition of acknowledged eminence in some branch of geophysics. Professor Madden was recognized for his advances in seismic and other geophysical theory and for inspiration of students and colleagues. . . . **Clifford L. Noll** recently completed 25 years of service with Foster Wheeler Energy Corp., where he currently serves as Western Regional Manager, Equipment and Fired Heater Sales. He and his wife, Muriel, are living in Littleton, Colo. They have four sons: Thomas and Richard, both in college, and Bruce and William, both in high school. Noll's hobbies include alpine and nordic skiing, hiking in the high country and photography. . . . **Bernard D. Steinberg** has written "Principles of Aperture and Array Systems Design: Including Random and Adaptive Arrays," a 1976 publication of John Wiley and Sons. Following his B.S. and M.S. degrees in electrical engineering from M.I.T., he obtained his Ph.D. from the University of Pennsylvania, where he is Professor of Electrical Engineering and Science and Director of the Valley Forge Research Center at the Moore School of Electrical Engineering. Dr. Steinberg lives in Windmoor, Penn. He is a fellow of the Institute of Electrical and Electronic Engineers and a member of Sigma Xi.

Charlie (Carlos) Davis has sent in a contribution which deserves more space than we can afford in this month's column; it will appear in the December issue.

Our class cocktail party during Alumni Day was held in McCormick Hall on Thursday, June 3. As always, it was an opportunity to renew ties with the regular attendees from the Greater Boston area and with more-distant class members who drop in. However, this year was unique in some

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Chemists' Neglected Social Imperatives

David E. Gushee, '50, is not yet ready to say precisely where they are. But he is convinced that there are physical limits to the ability of the earth to sustain man and his activities, that these limits "will irreversibly manifest themselves before too many more doublings of populations, energy consumption, food production, or waste generation," and that environmentalism, consumerism, and even the "energy crisis" are "essential prerequisites to some form of stable human society designed to coexist with itself and with nature on a permanent basis."

But as Chairman of the Industrial and Engineering Chemistry Division of the American Chemical Society, Mr. Gushee finds himself frustrated. "Many of our best technical minds," he writes in *Chemtech* (March, 1976), "have been committed over the past decade to . . . demonstrating just how unnecessary, unwarranted, and counterproductive these new constraints are." And at professional meetings and Congressional hearings alike, says Mr. Gushee, "the ratio of 'ridiculous requirement' stabs to 'profitable opportunity' propositions approaches infinity.

"It seems to me that to develop reactions with no by-products, or products with no waste-disposal problems, or processes with minimal energy requirements would be no more difficult than to develop fusion power . . . and certainly no more difficult than catalytic cracking . . ."

The present posture of U.S. chemists is ". . . no way for a profession to take center stage and play a leading social role," Mr. Gushee tells his fellow-chemists. — *J.M.*

respects: The cocktail party was jointly organized by the classes of '47, '48 and '49, which gave all of us opportunity to meet friends from the other two classes. Less happily, this was the first year **Stan Margolin** was unable to attend, having been shanghaied to an important client meeting in Pittsburgh on the previous day. Roz Margolin was also missing. **Paul Weamer**, cocktail organizer as Class President, was unexpectedly absent, in the throes of assuming a new job in Minnesota. Ginny Weamer was able to attend and did the honors for Paul. For the record, class attendees were as follows: Helen and **Pete Cambourelis**, Carolyn and **Manson Campbell**, Sue and **Russ Cox**, Nell and **Fletch Eaton**, **Archie Harris**, Sonya and **Frank Hulswit**, Jean and **Harry Lambe**, Muriel and **Ray Larsen**, Pam and **Mickey Ligor**, Eunice and **Joe Schneider**, and Ginny Weamer.

Best wishes to all and remember: "write if you get work." — **Frank T. Hulswit**, Secretary, 77 Temple Rd., Concord, Mass. 01742

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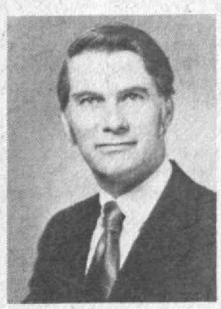
James P. Gay reports that his daughter, Barbara, has one more year to go at George Washington University Law School. His son, Jim, graduated from Colby College and hopes to go to Medical School. Jim and his wife, Jean, are kept occupied with their house, horse, and boat. . . . **August P. Doering** is presently working for S.D. Warren in Westbrook, Maine, as manager of commercial printing plate research. He has just completed a new home in Mineral Springs Estates on Lake Sebago. August used six-inch walls, as recommended in *Technology Review,* for the beautiful but cold Maine winters. . . . **William E. Wright** is Division Director for Physics, National Science Foundation. . . . **Carl F. Long** has been appointed a member of the Secretary of Commerce's Advisory Committee to Patent and Trademark office.

Louis Stark tells us he had a great time at the 25th Reunion last year. They stayed with the **Frank Parisi**'s down at the Cape on the following weekend. . . . **William W. Newitt** Chief of the Engineering Branch, Contract Administration Services Office, for the defense supply agency, is stationed at South Bend, Ind., under Chicago region jurisdiction. Bill has two sons, both serving in the U.S. Navy; one studying electronics and one involved in mechanical engineering. . . . **George E. Wetmore** is at Torque Systems, Inc., in Waltham, Mass., as material manager. George makes his home in Belmont, Mass.

Albert J. Romano, has been with ITT Gilfillan (radar systems) since December, 1973. He spent 1974-75 in Stockholm, Sweden, as management representative, air defense systems. Al has now returned to ITT Gilfillan, Van Nuys, Calif., in 1976, as senior program manager. . . . **Herbert D. Benington** left D.O.D. two years ago and was recently named to Vice President and General Manager, The MITRE Corp., Washington Operations. Herbert was elected to the Montgomery County Board of Education in 1974. . . . **J. Bruce Ingold** is presently general manager of Barber-Colman's Precision Dynamics Division, an international manufacturer of controls for aircraft, diesel engines, steam turbines, gas turbines, and other applications which require precise control of speed and power.



R. Stanley Bair, '50

John T. McKenna, Jr., '50

Kenneth Olsen on Massachusetts: What Good is the Environment if it Offers No Jobs?

Despite a good many roadblocks put in place by well-intentioned citizens who want to have their cake and eat it too, Kenneth H. Olsen, '50, likes living and doing business in Massachusetts. And he has no idea of moving his Digital Equipment Corp. (D.E.C.) — the world's largest manufacturer of minicomputers with 10,600 workers in Massachusetts, 20,000 worldwide — anywhere else.

But he's uneasy. Massachusetts and its citizens do in fact seem to work together to create a bad business environment in the state. The reason is simple: they believe an outspoken minority whose priorities are not really attuned to the people's needs, says Mr. Olsen.

"The people believe that business is just waiting to get in to spoil the environment, and all they have to do is say 'no' and everything will be okay. . . . People have no idea that in order to have a business you have to drive to work, and you have to get the material in and out with a truck, and you have to have airplanes. . . . People have no idea (of the) connection between these things, which all of them hate, and jobs," Mr. Olsen told Laurence Collins of the *Boston Globe* at the end of D.E.C.'s annual meeting late in the fall.

Among that vocal minority Mr. Olsen listed the *Globe* itself, which he considers anti-highway and anti-airport.

"It's Nicer . . . Somewhere Else"

Among misplaced priorities Mr. Olsen cites a state moratorium on new highway construction. Plans for an interstate highway through Hudson, Mass., were shelved three

Kenneth H. Olsen, '50

years ago, and so was a plan for a new D.E.C. plant there. "We bought the land, and we were going to build a plant. But they turned off the road. It's that simple," Mr. Olsen told Mr. Collins. And Logan Airport in Boston, a frequent target of protest by nearby residents: "We would not be here without that airport!" said Mr. Olsen.

"There's another factor people don't understand: Business doesn't go out and get into trouble. . . . We just go where we're wanted, because we just can't afford to get into . . . trouble. . . . No business is going in and hassle. . . . It's just so much nicer going somewhere else."

Would D.E.C. build a new plant in Boston? Not if — as he fears — it means being accused of "tearing down somebody's vacant lot where they're playing softball." But D.E.C. has opened a plant in the ghetto in Springfield, Mass., because "Springfield wanted us there. . . . A great success! Ninety-five per cent of the people we hired were unemployed."

Mr. Olsen's advice, when the time comes to build a new factory: "First thing you do is read the local newspaper, maybe go over to the barber shop to see what people think. You find out whether you're wanted; you don't go asking for trouble."

Dan E. Flanders and his wife, Vicki, are living on Back Bay in Biloxi, Miss., and are really enjoying the slow pace, the tall pines, and the fantastic boating and fishing — three boats, no less. Their grown daughter, Barbara, is in real estate and their son, Danny, is another "Boots Randolph" on sax in junior high school. . . . **Grant N. MacDonald,** was recently promoted to general manager, Corporate Laboratories. . . . **Roy W. Roth** was recently transferred to the Kendall Co. in Walpole, Mass., as Director of Product Development, nonwoven products. Dr. Roth and his family live in Weston, Mass. . . . **Edward J. Freeh** resigned as Professor of Chemical Engineering at Ohio State after 15 years in the academic community to become Manager of Process Control for Duval Corp. in Tucson, Ariz.

We recently heard from James Keefe, brother of **John R. Keefe,** who tells us that John has been ill for the past 16 months. At present he is at the Soldiers Home in Chelsea, Mass. (Quigley Memorial). John's illness is due to a recurrence of a Korean War disability. . . . Among recently elected members of the American Academy of Arts and Sciences are **Herbert S. Bridge** and **Kerson Huang**, professors of physics in the M.I.T. Department of Physics. Professor Bridge is also Associate Director of the M.I.T. Center for Space Research. . . . **Donald R. Miller** has joined the Chicago-based management and engineering consulting firm of Lester B. Knight and Assoc. Inc., as Senior Vice President. Don will be responsible for the firm's services to the retail industry and all phases of the firm's management consulting practice in the eastern region of the United States. Don and his wife live in Forest Hill, N.Y.

R. Stanley Bair has been elected a vice president of The Construction Specifications Institute. Stan, a professional member of the Houston Chapter of C.S.I., is owner of the architectural firm of R.S. Bair Associates of Houston. C.S.I. is a national technical society with 130 chapters across the nation. Located in Washington, D.C., the Institute serves as a national clearinghouse for architects, engineers, and other members of the construction team whose primary concerns are specifications and communications.

We regret to announce the passing of **H. Allen Stormer** who died January 13.

Richard K. Rockstroh has become Vice President, manufacturing, of Amchem Products, Inc., in Ambler, Penn. He continues his involvement with student cultural exchange programs in North Pennsylvania High School. Dick tells us that his son, Kurt, graduated from Rensselaer in Architecture in 1975; son, Carl, graduated from Hobart College in Psychology in 1976; daughter, Lynn, is attending North Pennsylvania High School. . . . **Kenneth H. Olsen,** founder and president of Digital Equipment Corp., Maynard, Mass., was elected a five-year Term Member of the M.I.T. Corporation. He has been a Term Member of the Corporation since 1971 and a member of the Corporation Visiting Committee for the Depart-

ment of Electrical Engineering since 1968, and its chairman since 1973. He also is a member of the Libraries Visiting Committee. . . . **John T. McKenna, Jr.**, of Bedford, Mass., has been elected to the Board of Directors of Boston Gas Co. Jack, Vice President of Boston Gas Co., is responsible for the production and gas supply and planning departments and all plant facilities. A resident of Bedford for the past 19 years, he has served as Chairman of the Board of Health and Planning Board. He is currently serving as clerk of the Board of Appeals and is a member of the Bedford Housing Authority. He and his wife, Dorothy, who teaches at the John Glenn Junior High School, have four children. Jack is also class secretary. — **John T. McKenna, Jr.**, Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

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The 25th Reunion is over, and it can be fairly said that the Class of '51 merits the title "The Record Breakers." You are probably aware that we had the largest number of alumni returning for the reunion, and adding the other family members attending we had the largest attendance of any reunion. We had the largest percentage of the class to give to the 25-year gift and our class gave the largest of any 25-year reunion class in the U.S. In all it was a memorable event and I must say a lot of fun.

Not all of us, of course, were able to make it. **Walter Wells** sent his regrets at missing the 25th. He shared with us his first-time excitement at becoming a grandparent of a 7 lb., 10 oz. baby boy, Nicholas VanWingerden II. . . . An old friend, **Paul Sanders** also had to miss the reunion. Paul celebrated a silver anniversary with Boeing Co., in Seattle, where he is the E3-A Program Manager.

I am happy to report a couple of very interesting career changes: **Dick Alden** has just started his own business called Alden Games. They are thinking-type games and the first product is something called Tic Tac Math. . . . **Dick Kolk** gave up engineering for teaching, got his doctorate from U. Conn. and is now Chairman of Electrical Engineering at Hartford Graduate Center.

More dramatic job changes were reported by **George Hughes** and **Eldon Heaton**: George has retired from the academic world and now lives in a community called Twin Oaks in central Virginia. He is one of a group of about 70 people who live communally doing farming, construction and cottage industry type work. He finds the life satisfying and challenging. Ed, after spending 20 years in industry in instrumentation, microelectronics and nuclear radiation effects, now owns and operates a Christian bookstore and wholesale book company.

We have promotions to announce: **George Thompson** has been promoted to Associate Professor at the Rochester Institute of Technology. . . . **Fiore DiGiovine** is now Vice President of Administration of the Plymouth Rubber Co., in Canton, Mass., responsible for materials management, purchasing, data processing and industrial engineering. . . . **Herb Scher** has been promoted to Chief Laminate Engineer for the Nevamar Div. of Exxon Chemical, after a career of introducing innovations into the field of laminates. . . . **Tony Stathoplos** was promoted to position of Projects Manager' Nuclear Reload Fuel, Nuclear Power Systems for Combustion Engineering, where he has been since 1970. . . . **Art Wasserman** has recently been promoted to Area Vice President Eastern European Operations of Allis-Chalmers.

In the field of architecture, **Don Brown** designed an all-aluminum house for Reynolds Metals that was air freighted to Iran for evaluation in that part of the world. . . . Our classmate, **Elisha Flowers**, was architect for the San Antonio Art Institute's new building. The president of the Art Institute feels that this building is worthy of recognition by the American Institute of Architects and merits consideration for an award of excellence. How about a photo of the building?

Dave Caplan has been named Vice President Engineering for Inforex Corp. in Burlington, Mass. Dave had been Director of Engineering for Raytheon Data Systems. . . . **Alec Tachmindji** has been named Vice President of Washington Operations of MITRE Corp. Alec was previously MITRE's Chief Scientist and prior to joining MITRE, he served as Deputy Director of the Defense Advanced Research Projects Agency and as the Director of the Tactical Technology Office.

Frank Packer had been in Japan in the Tanker Dept. of Esso International Corp. Apparently tanker construction is winding down fast in Japan and Frank will be returning to the U.S. this month to be stationed at Exxon Headquarters in New York. . . . **Ed Stringham** has been President at Penetryn International, Inc., since 1964. The company was recently merged into the Carborundum Co., and Ed is now in their research and development dept., working in the Waste Water Management Division.

Bill Whiston is returning to the University of Massachusetts after 24 months at the National Science Foundation. . . . **Herb Graham** designed a unique bicentennial report to tell us of his recent relocation. Herb is with the TRW Energy Systems Group in Washington, D.C., having just transferred from one of their Colorado operations. Intracorporate transfers can be complicated and colorful, and apparently Herb's was all of that. . . . **Frank Monkman** has just arrived in Oklahoma and has had sufficient time to validate **Breene Kerr**'s prior endorsement of that state. — **Samuel Rubinovitz**, Secretary, 3 Bonser Rd., Lexington, Mass. 02173

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This month there is a substantial quantity of news from our classmates. First, a note comes from **Boris W. Batterman**. He writes that he is Director of the School of Applied and Engineering Physics at Cornell University. . . . Also in the scholastic area is **Randall W. Kirk**, who is lecturing in transportation management at the University of Texas (Austin) College of Business Administration.

Francis E. Courtney reports his experiences since graduation. From 1952-56 he was on active duty with the United States Air Force. From 1956-67 he was a scientist for Lockheed in Georgia. In 1967-70 he was a senior meteorologist at Dames and Moore. Continuing his meteorological work through the years 1970-76, Frank was Air Quality Manager and Vice President of Woodward-Envicon, Inc. Since 1976 he has been with his own company, F. E. Courtney and Associates, Environmental Consultants, Atlanta, Ga. . . . Another in the business community is **George Jordan**, who writes that he bought Medical Plastics, Inc., Minnetonka, Minn. George's three children are now all in college. . . . **Dick Wingerson** is now busy building his retirement home. He notes that being a carpenter is an interesting change from being an Air Force Colonel. "National scandals notwithstanding, skiing here (in Crested Butte, Colo.) is great."

The highest award of R.C.A. Government and Commercial Systems was conferred on **Walter R. Wadden, Jr.**, of R.C.A.'s Automated Systems Division in Burlington, Mass. Walter was recognized for his outstanding efforts on Maroon Shield, a classified government program. He is a senior engineering scientist at the R.C.A. facility, and lives in Bedford with his wife and son. . . . **Daniel T. Anderson** writes that since he was graduated from M.I.T., he acquired a law degree (J.D.) from the University of Southern California. Dan is now Chief Patent Counsel for TRW, Inc. . . . **John S. Rydz** is Vice President of Engineering, Sewing Products Group, Singer Co. John is responsible for engineering, manufacturing engineering, and quality assurance in Singer's worldwide consumer and industrial group.

Another Vice President is **Phil Sperling**. Phil was promoted to Head of Corporate Research and Development for Coats and Clark, Inc., in July, 1975, and became a Vice President on June 1, 1976. Phil has been with Coats and Clark for 21 years, starting as a project engineer. He has two children, Kathy, 21, and Kenneth, 18. Kathy is a senior at Duke University and Ken will be a freshman at Duke in the fall. His wife, Florence, is still busy as an art teacher in the Cranford, N.J., school system. Phil and his wife have resided in Cranford for 18 years. . . . **Richard H. Daly** writes that he is at Raytheon as Department Manager.

Classmates seem both incredulous and proud of the 6.4 pound "brass rat" which commemorates the record-breaking gift of the Class of '51. It is now on display in the M.I.T. Historical Collections.

Richard is also still on the Framingham, Mass., School Committee. He has two children in college and five more to go!

Stanley Sydney, whom many of you know as Treasurer of the Class, has recently been cited an honored member of the Jewish community in the Boston area. Stan is President of the Sydney Construction Co. and a partner in the Sidney and Winn Development Association. He is Vice President of the Architects and Engineers Chapter of B'nai B'rith. Stan is also Treasurer of the Maimonides School of Brookline. He was cited for his efforts in the construction of a new school house on the Brookline campus of the New England Hebrew Academy. Stan, his wife Sheila, a graduate of Simmons College, and their five children live in Brookline. His children are Michael, 19, attending Northeastern University; Roberta, 17, who will enter Wellesley College this fall; David, 15, Judy, 12, and Elana, 5, are all students at the Maimonides School.

Charles H. Beckmann, a Colonel in the U.S.A.F., has been selected Chief of Cardiology Service in the Department of Medicine at Wilford Hall U.S.A.F. Medical Center, Lackland A.F.B., Tex. Dr. Beckmann is Clinical Asistant Professor for Medicine at the University of Texas and is certified by the Subspecialty Board on Cardiovascular Diseases of the American Board of Internal Medicine and the National Board of Medical Examiners. He is a Fellow in the American College of Physicians, American College of Cardiology, American College of Preventive Medicine, Council on Clinical Cardiology, and American Heart Association. Dr. Beckmann became a Flight Surgeon in July, 1961, and received the Air Force Commendation Medal in 1970 and the Air Medal in 1972.

The United States Department of Commerce News has announced that **J. Leith Holloway, Jr.** has developed a model simulating the hydrologic cycle and climate in the atmospheric circulation. The mathematical model simulates the seasonal changes in the movement of water through the global environment. . . . **Bernard N. Cahlander** was accorded a license as an architect in California in 1974. . . . **Arnie Kramer**, Chairman of our 25th Reunion Committee, asks that any classmates interested in helping with the reunion — to be held in June, 1977 — contact him. His address is Mechanics Furniture Manufacturers, Inc., 306 Shrewsbury St., Worcester, Mass. — **Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, Mass; **Richard F. Lacey**, Assistant Secretary, 2340 Cowper St., Palo Alto, Calif.

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Out of the blue, I have received a couple of calls from **Jay Berlove** (who now is with Mobil and travels extensively). Let me warn you that his gambling instincts have not waned; and, sadly enough, he has me on the weak side of a Carter-Ford bet. (I must have been drinking!) **Jake Pinkovitz** is now a regional manager of some whing-ding operation in Massachusetts (remind me, Jake) and called when passing through Greater Pittburgh one evening. Calls from any of you will be welcome, and hospitality will be forthcoming if your schedule permits. . . . From the news bag: **Dick Simmons** (now President of Allegheny Ludlum Steel Corp.) was recently elected to the Board of Directors of Pittsburgh National Corporation, holding company for Pittsburgh National Bank. . . . **Jerome Tiemann**, now a physicist at the General Electric Research and Development Center at Schnectady, was honored with a Coolidge Fellowship award this June. Tiemann has spent nearly 20 years with G.E., first conducting fundamental studies of interband tunneling, then turning his attention to the optical properties of semiconductors, and more recently working in the field of charge transfer technology. In the process, he has received 40 patents, written 40 technical papers, and been active on the seminar tour. . . . **Marty Levine** (presumably with Center for Astrophysics in Cambridge) has been conducting some interesting experiments (reported in the *Boston Globe*) with a $3-million super-accurate hydrogen maser clock in order to measure the "warping" of time in space, as postulated by Einstein and validated by Levine and his cohorts (according to their "quick look data"). To the extent that I can understand it, they are testing both the "twin-paradox" and equivalency principle with their fancy rocket-borne clock and, thus far, have met with considerable success. (In an earlier issue, I brought you up-to-date on his quasi-political activities.) . . . **Bruce Murray** continues in the news, the latest being an interview with the *Christian Science Monitor*. (*See page 7.*) As reported, Bruce (now Head of the Jet Propulsion Laboratory at Cal Tech) is opposed to spaceship searches for foreign civilizations or even massive, interstellar, radio-telescope systems, such as "Cyclops," feeling that a more modest and localized search for alien radio signals will be much less costly and more appropriate. He feels that it now is reasonable to assume that "we are not alone" and argues strongly for planetary exploration (though apparently not the manned type).

Am sorry to report that **Stan Silverman** died last December. I have little information other than he, his wife, and teen-aged son were living in Scotch Plains, N.J.

Was pleased to receive a long letter from **John Jeris** and learn his whereabouts. John "gravitated" (after three years in consulting and another three working at M.I.T. on his Sc.D.) to Manhattan College, and he plus wife (Helen), a daughter, and a son — has settled in Yonkers, N.Y., is enjoying local community affairs, little leagues and the like. At Manhattan, he is Professor and Director of Environmental Engineering and Science (a graduate program) and enjoys "a rewarding professional life;" just for the hell of it, he helped start a small company (Ecolotrol, Inc.) to develop and market some water pollution treatment technology and noise detection instrumentation — but insists that thus far it has been a losing proposition. Well, John — here's hoping you strike it rich (and share profits with the Alumni Fund).

Short notes from the Alumni Fund grab-bag: **Ralph Eldridge**, like all of us, wishes he could give more (to the Alumni Fund) but notes that ". . . with three in college I'm wiped out." **Albert Reynolds** is now an Associate Professor in Nuclear Engineering at the University of Virginia but will spend the coming academic year at the Centre D'Etudes Nucleaires in Grenoble, France, working on fast nuclear safety. . . . **William Lincoln** is retiring from the Army after 30 years of service and will begin working for TELCOM, Inc. in McLean, Va., as Managing Director. . . . **Joseph Mullen** reports, "Having taken an early retirement from Combustion Engineering, I am now located in Honolulu working harder than ever with the sugar, steel, cement, utility, and process industries as Vice President-Operations, Central Pacific Boiler and Piping Ltd." . . . **Douglas Fuerstenau** was elected to the National Academy of Engineering last spring and also received the Robert H. Richards Award from the American Institute of Mining and Metallurgical Engineers. . . . **Philip Stark** wrote, "Hearty greetings to my fellow classmates. Joined Norton Company (Grinding Wheel Division) in 1966. Presently am Director of Research. Have two boys — Jonathan, 13, and David, 17. David will be entering Brandeis University this September as a freshman." . . .**Charles Desoer** was co-author of the 1975 Montefiore Prize book, *Feedback Systems: Input-Output Properties*. . . . **Robert Curley** reports that he "received a M.B.A. degree in May from Boston College; an interesting (and valuable) experience after being away from a formal education environment for more than 20 years. Highly recommend B.C.'s program." . . . **Dick Lindstrom** recently saw **Harry Krimbill** at Dow Chemical in Midland, Mich., but said that "[Harry] didn't have time to talk as he was headed out the door to a business (?) meeting in Bermuda." Dick is still sequestered (how's that, folks?) and busy at A.D. Little in Cambridge. . . . At least one of us clearly has it all together! And that is **Hue Harriman**, who wrote: "I have left the 'corporate rat race,' too — 3 years ago. Have a fast-food-restaurant franchise in Key West. When I have time I enjoy drinking fine wine and do a little sailing. Ginny and I just returned from a tour of New Zealand and Australian vineyards and wineries." (Hue: Do you sommelier? If so, call collect!)

Richard P. Simmons, '53

Well, that's all, guys and dolls. Keep giving and writing (though *my* major concern is with the latter). — **Martin Wohl**, Secretary, 7520 Carriage Ln., Pittsburgh, Penn. 15221

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Our poll of classmates was a great success. We have enough news to last for months. Our information indicates we have a very dispersed (ideologically and geographically), talented group.

Hugh Nutley is Professor of Physics and Engineering Science at Seattle Pacific College (S.P.C.). S.P.C., like many other colleges, recently raised some capital for building development and will have a new science building this fall. Hugh finished an M.A. in English in 1974 at the University of Washington and expects to get an M.S. in chemistry engineering this year. As many of you know, Hugh previously earned his Ph.D. in physics. Hugh has undergone an attitude change from the negative feelings when he lost his savings in the stock market, to an increasingly positive feeling as he built his own house, finished his Ph.D., while his wife Frid finished her M.A., to the satisfaction of raising six healthy children, and guiding their ideological and spiritual development.

It is interesting to see the growth from a concern over materialistic things, to pride in self-accomplishment and in helping others to develop. Several other classmates expanded their notes to include insights into their thinking, and we hope more will follow this approach.

Jim Hazard is developing special purpose machinery for Scott Paper Co. Jim serves on boards for "The Heritage Ship Build of the Port of Philadelphia" ("Rebuilding ships that any sane person would scuttle"), and an amateur theatrical group. Daughter Terry (along with Chuck's daughter Nancy), is at Connecticut College. Jim's son, Ron, is starting Lafayette in September, and his wife Ann is Vice President of the school board, and a "tennis nut." Jim heard that **Bill Nance** is still living in Los Angeles and does plenty of sailing. **Kevin Woelflein** is operating at the forefront of the new Arab opulence. He was elected President of U.B.A.F. Arab American Bank, a consortium of four American Banks, five Arab consortium banks, and 11 Arab banks with capital of $25 million, and is located in the World Trade Center in New York City. The bank will engage in a wholesale banking business, and concentrate on international transactions.

Bob Byer is currently President of Resource Management Corp., a company with two subsidiaries: RMC Research Corp., in Bethesda, Md., a contract research organization specializing in cost and economic analysis of educational research, and Linden Laboratories, a manufacturer of piezoelectric components for ultrasonics in industry.

Dick Crowther is living in Crystal Lake, Ill. (near Chicago for you midwestern travelers), and is Components Group President for Illinois Tool Works Inc. He heads two divisions in the United States as well as divisions in the U.K., France, Italy and Spain. (**Dean Jacoby** please note: that familiar face on those cross-Atlantic trips is really

At the 20th Reunion in June, Mickey Reiss (left) was elected President of the Class of '56. He is President of Gamewell/Alarmtronics of Marlboro, Mass., and was chairman of the 20th Reunion Committee. Bill Grinker (right), Executive Vice President of American Used Computer, Inc., of Boston relinquished his post after serving as Class President for five years.

our classmate, Dick.) Dick's son Tim is completing his junior year at Mississippi State where he is studying agronomy (you look it up). Both Dick and Dean should drop in on **Manny Otis** in Brussels where he heads Control Data's Computer business for Western Europe.

Harry Taylor is living at Kiriat Ono in Israel. His daughter Alisa is completing her second year at the University of Virginia. His son Leon (16 months old) is starting to talk a mixture of Hebrew and English. Harry is "keeping young" by training new engineers and supervising graduate students studying in the Technion and in the U.S. — **Dave Howes**, Secretary, Box 66, Carlisle, Mass. 01741; Assistant Secretaries: **Chuck Masison**, 96 Spellman Rd., Westwood, Mass. 02090; **Lou Mahoney**, 14 Danby Rd., Stoneham, Mass. 02180

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We are happy to report a wealth of information this month which, hopefully, will set a precedent for the future.

On the business front, we are advised that **Robert C.K. Au** has been named manager of the Atlanta office of Dames & Moore, engineering and environmental consultants, responsible for all of the southeastern states. Au joined Dames & Moore as an engineer analyst in its Honolulu office in 1960 and later worked in the firm's San Francisco office. He transferred to Atlanta in 1969 and he became a partner in the firm in 1972. Bob has been responsible for multidisciplinary environmental studies of nuclear power plants, dams and transmission lines. He has also been in charge of site investigations of offshore structures, piers and wharves, high-rise buildings, industrial facilities and land reclamation projects. He is a registered engineer in 13 states and is a member of the American Society of Civil Engineers, American Society of Testing and Materials, and the American Consulting Engineers Council.

Dave Barnes' wife reports that he has continued entrepreneurial efforts to combine music and digital electronics. This has taken him recently into synthesizer design, developments in conductive rubber and promotion of an electric saxophone. He's also the manager of the rock and roll band PZAZ, for whom he has designed an innovative P.A. system and light show. . . . **Roger Broadwell** is currently the Manager of Quality Control, Timet Division of TMCA, Toronto, Ohio. He is married, has five children, two of whom are in college and has seen much of the world; including Europe, Canada, Mexico and all but six of the 50 states. He adds that the "Boston area is the best."

Gordon Lohman has been elected President of the Macwhyte Co., the Kenosha, Wisc., Wire Rope Division of AMSTED Industries. Gordon has been serving as president of the AMSTED Research Laboratories, the company's research center at Bensenville, Ill. He joined AMSTED in 1958 (after service in the Air Force) as a research metallurgist with its Griffin Wheel division. In 1961 he was transferred to the AMSTED Research Laboratories as a project engineer and was appointed Commercial Manager in 1962, Director of Research in 1967, and President in 1968. Gordon and his wife, Jo Ann, reside at 402 Fairview Ave. in Glen Ellyn, Ill., and have two children.

I conclude our business notes with a correction of a prior report respecting **Walter Shifrin**'s recent activities. Walt writes that he left Horner & Shifrin on January 1, 1969 and joined the firm of Consoer, Townsend and Associates. That firm has its headquarters in Chicago and he runs the St. Louis office. He joined the firm as a Senior Engineer, in 1970 he was promoted to Associate, and in 1972 he was made a partner. The firm has approximately 650 employees and does sanitary engineering work — primarily water pollution control, thoughout the country. I hope that the preceding straightens out the record.

John Rossettos writes that he recently co-authored a graduate level text (with P. Tong) entitled *The Finite Element Method — Basic Technique and Implementation* published by M.I.T. Press.

Some of us are completing one career and commencing a second. Thus, we learn that **Sherman C. Reed** retired from the Navy in 1973 after 27 years of service, some 20 years of which were spent designing and constructing many Navy ships including Woods Hole Oceanographic Institute's research vessel *Knorr*. He is apparently now launching a new career in politics, currently serving as chairman of the Republican Town Committee in Orleans on Cape Cod and recently having been a delegate at the Republican National Convention. . . . In a similar vein, **L. J. Williamson** reports that he retired on June 30 from the U.S. Coast Guard after some 33 years of service, and is now residing in Tallahassee, Fla. What's next, L. J.? . . . The Reverend **Roy E. Parker** has begun a career in the ministry, having entered the Order of the Holy Cross on March 20 of this year. He now is Prior of the Order's house in Berkeley, Calif.

Frank Curran advises of the birth of his fifth child, John Joseph, in February. . . . **Tom Thliveris** reports another, not uncommon problem — the task of saving to put his children through college. Tom's daughter started college this fall.

Finally, the ubiquitous **Denny Shapiro** writes to indicate that he and Sue spent a couple of weeks in May in Japan and Hong Kong. Denny advises that he gets to New York frequently to attend meetings at the new ADT headquarters on the 92nd floor of the World Trade Center, noting with some temerity that his new company "really believes that fire alarms and extinguishing systems work."

We end on one sad note by recording the previously unreported fact that **Steven J. Rau** passed away on October 17, 1974.

Please keep those notes coming. Your notes are both the bread and the champagne which sustain your correspondents. — Co-secretaries: **Marc S. Gross,** 3 Franklin Ct., Ardsley, N.Y. 10502; **Allan C. Schell,** 19 Wedgemere Ave., Winchester, Mass. 01890

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Seventy classmates plus their spouses, children, playmates and pets gathered for the best 20th Reunion one Alumni Office staffer had ever seen. Chairman **Mickey Reiss** greeted classmates at the sold-out M.I.T. Night at the Pops on Thursday. Friday evening we all celebrated at the Stratton Student Center, enjoying special attention from the staff of the M.I.T. Director of Physical Plant — our Reunion Vice-Chairman **Bill Dickson**. On Saturday we went way up the Charles to the River School Campus in Weston for a fabulous clam bake, arranged by Lorraine and **Ron Massa**. Ron's engineering and management skills are also applied as president of his own consulting firm, Dynatrend in Burlington, Mass. The children of all reunion classes had a busy program on campus — so busy that Ann and **Bing Cady**'s son got bussed off to the class of '51s clam bake where he was discovered and denied lobster! Five years from now we'll be more careful with I.D.'s. At the picnic we discovered that **Gideon Gartner** is on Wall Street as a computer industry analyst for Oppenheimer & Co. . . . **Regi Schultis** is Vice President of Smith Barney, Harris Upham & Co. . . . **Bruce Bredehoft** is an industry analyst with Loomis, Sayles & Co. in Boston. . . . **Bill Leitch** is Vice President of International Data Corp. . . . **Art Sirkin**, Account Executive at E.F. Hutton's New Brunswick, N.J., office, may or not have made clients of Nina and **Bob Krooss** — who may soon need investment counsel for the fortune which may evolve from Bob's firm, Pace Packaging Corp. in Fairfield, N.J. . . . **Ed Pease** is Vice President of the Investment Services division of Chase Manhattan Bank in N.Y.C.

The afternoon of lobsters, clams, sunshine, drinking and visiting was followed by a dinner dance and informal business meeting at McCormick Hall. The several awards included again the long-distance prize to Eva and **Nelo Sekler-Nussembaum** of Caracas, Venezuela — shared this time with **Bernardo Blaschitz**, also of Caracas. **George Tsirkas** was presented a crying towel to help in his new job as Director of Financial Planning of the New York City Health and Hospitals Corp. George and Angela brought their two children to the reunion. Betsy and **Jim Fleming** attended with the four children. Jim, as the Vice President of the Chiquita Division of United

In late June some 50 alumni and their guests gathered at the estate of Pauline and Francis Mesker, '27, for the annual picnic of the M.I.T. Club of St. Louis. The quiet summer afternoon was punctuated by occasional blasts from the horn of the riverboat *Washington* — an actual steam powered riverboat which Frank acquired and moored at the edge of his lawn — which greeted the barges plying their way along the Missouri River. In the photo below from left to right: Erwin Stedronsky, CM '70, sitting on the rail; Pauline Mesker, on lounge chair; Les Eastwood, '69; Bill Dennis, NC '49; and Rick Ryckman, CE '56.

Brands in Boston, observed that we had no bananas with the lobster. Perhaps he'll bring a boatload to our 25th. **Margie Gilson** was applauded for her very effective five years as co-secretary of our class. Bruce Bredehoft will continue as co-secretary with **Warren Briggs** who was elected (appointed, designated, nabbed?) that evening. Bruce and Marion missed their applause when they were called to the hosptial to visit their son, Brad, who broke his arm chasing a frisbee at the clam bake. The Committee's responsibility for such dangerous missiles is still unresolved. Each classmate received a ceramic mug at the banquet to commemorate our great vintage. Extras are available from Mickey Reiss (at Gamewell/Alarmtronics, 91 Bartlett St. Marlboro, Mass. 01752. A minimum contribution of $8 each to the Class of '56 is suggested). Nelo Sekler remarked that he will fill all these mugs with Venezuelan petrol if we plan our 25th Reunion in Caracas.

Other elections at the brief meeting included **Walter Frey** as our Class Agent and Vice President, and **Arnie Schindler** as Class Treasurer. Also we elected a talented and hopefully dedicated group of Vice Presidents including **Paul Cianci**, **Ed Baker**, **Bill Dickson**, **Ted Korelitz**, Margie Gilson, **Roger Borovoy**, Ron Massa, **Irwin Gross**, **Andy Edmonds**, **Gordon Black**, **Dave Shefrin**, **Jerry Solomon** and **Paul Polishuk**. Finally we applauded the tremendous job Mickey Reiss did as Chairman of the Reunion by his election as our Class President for the next five years. **Bill Grinker** is a hard act to follow, but we all know Mickey likes challenges. We'll miss Bill's leadership as President, but will certainly keep him involved.

We hope to hear more news from our classmates. The new co-secretary would also like more pictures. We have a great interest built up in the class right now which we hope to continue until our very special 25th Reunion. — Cosecretaries: **Bruce B. Bredehoft**, 3 Knollwood Dr., Dover, Mass. 02030; **Warren G. Briggs**, 33 Bancroft Rd., Wellesley Hills, Mass. 02131, Telephone: (617) 235-7436

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We have a lot of news this month — it was great to hear from so many of you. **Bob Barnes** wrote to say that he had been promoted to Professor of Philosophy at Lehigh University. He has also been appointed Borough Councilman of Fountain Hill, Penn., filling a vacancy on the council there. . . . **Stan Cortell** writes to say that since September, 1975, he has been an Associate Professor of Medicine at the College of Physicians and Surgeons of Columbia University and Chief of the Division of Nephrology of St. Luke's Hospital Center in New York City. . . . **Lou Becker** also had a promotion last September, to Professor of Information and Computer Science at Northeastern Illinois University; he has been Chairman of the Information and Computer Science Department since July, 1970. Lou and his wife Loretta, who is teaching mathematics and computer programming, have three children.

George Malaney is Professor of Sanitary Biology in the Department of Environmental and Water Resources Engineering at the School of is currently living in Tehran, Iran, employed by American Bell International. After 20 years as a U.S.A.F. Meteorologist, Major **Gordon Spillinger** is retiring and heading for the Pacific Northwest and a second career. . . . **Tom Reinhart** writes that he is now working with Sedco of Dallas, Texas, an international offshore contractor, in areas of ocean mining and deep water dynamic positioning. Tom's daughter, Nancy, will enroll in Texas A&M to be an ocean engineer; Tom also has three sons and feels confident that "there's bound to be at least one Tech man." . . . **Bruce Grover** and two partners have bought Vinyl Plastics, Inc., a manufacturer of floor tile and plastic packaging located in Sheboygan, Wis. Bruce has also started an amateur astronomy group ofwhich he is the President and constructed an observatory in his backyard to house his telescope. . . . **Howard Schumacher** writes that he is now Engineering Manager at Fighton, Inc., a minority-owned company designing power supplies and transformers. . . . **Bob Rosin** dropped us a note to say that he was moving to Fair Haven. N.J., in June to join the technical staff of Bell Laboratories in Holmdel, N.J. . . . **Dominick Fortunato** wrote a note saying that he and his wife and three children recently took a five-week vacation in the Philippines to visit his wife's family. Dominick has recently been assigned as a project engineer on the Clinch River Reactor Plant Project for Burns & Roe, Inc. **Jim Cunningham** wrote and asked us to promote the On-Campus reunion in June, 1977. We hope to see many of you there — with a year's notice, there shouldn't be too many good excuses for not attending! Early indications are for an excellent turn-out and there will be more details about the reunion in an early-fall mailing.

I've received a press release about **Peter Samton** taking office as the First Vice President and President-Elect of the New York Chapter of the American Institute of Architects. Peter is a partner in Gruzen and Partners, New York City, where he is the Director of Design. In the June issue of *Reports on Research,* an article about the work **Larry Young** and a number of others at M.I.T. concerning "the mechanism and limitations of the system in the inner ear by which we orient ourselves in space." It sounds like interesting work. Our last note is from **Dave Gillis**, who says that he has been trying to manage a small part of the Hughes Aircraft Co. as a Department Manager for the last three years, but he has decided he is probably not a "key person" and will take to his motor home and "look for a more favorable version of H.R. Hughes' will." Good luck, Dave!

It was great to hear from so many of you this time, and now I hope some of the rest of you will be inspired to send quick notes about what you are up to. — **Fred Morefield**, Secretary, 285 Riverside Dr., New York, N.Y. 10025

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Welcome back after the Bicentennial summer. For those of you who saw the Boston July 4 Pops concert and fireworks on television, you may have noticed me — the pin dot in the lower right of your screen — about 5,000 yards down the Esplanade. It was a warm and friendly evening despite the huge crowds — a truly memorable time. Hope your own celebration was equally as delightful.

Summer also occasioned several get-togethers with other class members. **Al Russell**, now Associate Professor of Mechanical Engineering at the University of Massachusetts, wandered into my office on the waterfront in Boston and brought me up-to-date on his activities. In addition to teaching graduate and undergraduate courses, Al founded an acoustical consulting firm, Russell and Ivey, specializing in environmental noise impact studies and technical assistance, including testing for noise control projects. Al and Beth and their three children are living in Amherst. . . . Mary and **Bernd Gunther**, along with Kathy and **Glenn Strehle**, recently became co-owners of a sail boat which they keep anchored at Buzzards Bay. One very sunny and very windy day found yours truly a guest aboard with the Strehles for a heeled-over, wet, and exciting day of sailing. The following week Bernd and Mary were headed off for their vacation on the boat. Bernd is with ThermoElectron Engineering Corp. in Waltham, and they are living in Framingham.

Bob Ricci completed the Sloan Fellows' Program and received his S.M. this past June. He will be returning to the Transportation Systems Center in Cambridge. . . . **Ed Newton** has become Plant Manager of GTI, Clover Industries in Tonawanda, N.Y., and Ed and his family have moved to Amherst, N.Y. . . . **David Nixon** is President of Circuit Test Laboratories in Scotsdale, Ariz., and the family — wife, Diane, and 8-year-old son, David — are living in Phoenix. All report that "it's a great life! — super recreational area with tennis, golf, and swimming in our own pool!" . . . During the previous summer, **Tom Fuller** visited Boston

with his family on a vacation trip. They found the parking situation even worse than they imagined but said that "thanks to an M.I.T. parking lot attendant we were able to park on Campus while I took our kids on their first subway ride from Kendall Square to downtown Boston and back." . . . Barbara and **Mark Dandrea** have rounded out their family with their sixth child, a girl, and now have three boys and three girls. Mark is still with the General Electric Company, Aircraft Engine Group as Manager, Material Joining. . . . **Robert H. Wilcox** visited Boston this past winter on "home leave" from his tour as Scientific and Technological Counselor for the U.S. Embassy in Buenos Aires. Bob writes that his eldest daughter, Susan, has completed her freshman year at Stonehill College in Massachusetts, and he says that, "wherever possible, I attend the monthly dinner meetings of the M.I.T. Club in Buenos Aires." . . . **William Dreier** has been elevated to the Union County Court by Governor Byrne of New Jersey. Bill was first appointed to the bench in 1973 and has served since then as a County District Court Judge, temporarily assigned to the Superior Court, hearing civil matters. He recently completed a course at the National College of the State Judiciary at the University of Nevada in Reno. . . . **Charles Leonard** has been elected a Vice President of William E. Hill & Co., Inc, a management consulting firm with offices in New York and overseas. Since 1965 he has been active in the firm's practice in business strategy development and diversification planning. Previously, he was employed at Dupont. — **Michael E. Brose**, Secretary, 30 Dartmouth St., Boston, Mass. 02116

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A truly marvelous summer as a wealth of notes, letters and news releases were received from class members. So getting right to them: **Merrill Minges** was honored last February as one of 12 men to receive Outstanding Engineer and Scientist Awards from the Engineering and Science Foundation and Affilate Societies of Dayton, Ohio. Merrill obtained his Ph.D. in chemical engineering from Ohio State after completing work at the Institute. He is currently Chief of the Elastomers and Coatings Branch of the Air Force Material Laboratory and, in addition to his work at the Laboratory, actively participates in numerous national and international technical study groups. . . . Nearby in Cleveland, **Oliver Seikel**, in the private practive of law was recently elected a trustee of the Catholic Charities Corporation.

George Snyder was recently appointed new products manager for the Dravo Lime Co. in Pittsburgh. The news release about you, George, talked more about the products. How about a short note to fill in the intervening years? . . . On the Washington scene, **John Christie** was appointed Assistant Administrator for Policy and Analysis of the Federal Energy Administration. After graduate work, John was at Bell Labs and more recently at the Defense Department. . . . **Lawrence Roberts**, President of Telenet Communications in Washington, was the recipient of the 1976 Harry Goode Memorial Award of the American Federation of Information Processing Societies. Prior to joining Telenet, he led the computer software group at Lincoln Laboratory and was with the Advanced Research Projects Agency of the Defense Department.

On behalf of the class, congratulations to **John Brauman**, professor of chemistry at Stanford, on his election to the National Academy of Sciences.

The career mailbag noted that **Leonard Tannen**, Vice President and General Manager of Fermentation Design, Inc. was recently elected to the Board of Directors of the parent company, New Brunswick Scientific. . . . **George Connor** was promoted to Lieutenant Colonel in the Army and is working in the area of the design and construction of new propellant and explosive plants. . . . **Donald Spiller** and his wife, Ann, have recently moved to Tokyo for a two-year assignment with IBM-Japan as manager of foreign account marketing. . . . **Bob Turner** was appointed plant engineer of Hiram Walker & Sons in Canada (does this assure a cash free bar at the 20th reunion?) and also serves as chairman of the facilities committee for the Windsor Western Hospital Center. . . . **John Brackett** has been named President, Director and Chief Executive Officer of SofTech, Inc. in Waltham, one of the few successful new enterprises of recent years. . . . Good luck to **Fred Cox,** who has started a new company in Newport Beach, Calif. — Manufacturers Capital, which will specialize in equipment leasing.

Further updates from **Don Avery**, professor of engineering at Brown, who journeyed to Tanzania this summer to study iron age smelting. . . . **Donald Hunt**, Vice President of Manufacturing for Hilsinger-Evans. . . . **Ken Kreider**, manager of industry program with National Bureau of Standards Office of Energy Conservation. . . . **Bill Widnall**, the first Congressional Fellow of the American Institute of Aeronautics and Astronautics, returned to Intermetrics in Cambridge where he was promoted to manager of the Navigation, Guidance and Control Department. . . . **Robert Ziegelman**, lecturer in architecture at the University of Michigan, was appointed as a member of the Michigan Association of the Professions and recently received the Michigan Society of Architects Award for his design of a medical office building. . . . **Sam Fryer**, now located in Tulsa as manager of chemicals for Skelly Oil, would like to hear from any classmates in the area. . . . And **George Elbaum**, still actively commuting between Los Angeles and Moscow in his commercial representation of U.S. companies, is looking for a cure to jet-lag!

Willard Johnson, currently assistant chief of surgery at the Boston Veterans Administration Hospital, is looking for ideas from classmates in regard to the installation of solar energy systems. . . . **Bob Schumacker** sent a note from Salt Lake City where, with Evans & Sutherland Computer, he is working on the production of visual computer systems for military and commercial flight training. . . . **Lowell Anderson**, his wife, Sara, and their young son have recently moved to Cody, Wyo., where Lowell will provide on-site support of a new computer installation for Honeywell Information Systems.

Peter Glenshaw has a full and busy life in Reston, Va., where he provides financial and economic consulting services in his own business and combines this with an equally occupying home life centered about his wife and their six children. . . . **Richard Barnes** described himself as a "feminist agitator" as Vice President of the Johnstown (Penn.) Chapter of the National Organization for Women. He also serves as a member of the M.I.T. Educational Council.

Our active Alumni Fund traveler, **Ron Stone**, reports that **Mal Chase** directs a laboratory group for Dow Chemical in Midland and that the consummate Californian, **Rik Hall**, has moved to Maryland where he is an I-R spectroscopist in Gaithersburg.

Elmer Delvental announced his marriage this past May to Katherine Korell. His new wife teaches art at community colleges in Connecticut and according to the recent Alumni Register, Elmer is also a teacher of mathematics at Central Connecticut State College.

Regards to **Bob Muh** from **George Barnett**. George also notes that his young son (age 8) is already thinking about M.I.T. and that he is a better athlete than George. I don't know if George is slowing down or that he never did run that fast!

A long and detailed newsletter and biography was received from **Stewart Mott** who described himself as an "avant-garde philanthropist" and who actively supports a number of national and international projects from his Washington office and New York penthouse. The simplest way to encapsulate his hectic and broad activities are in his own words, "to work in the Fourth Branch of government — thinking of myself as a junior-grade Ralph Nader or John Gardner."

Phil Beach is in Sao Paulo, Brazil, where he is Food Director for Borden, Inc. in Brazil. Phil noted that last April, Liliane Van Parys ended his relatively short-lived second bachelorhood and that in addition to his own two children, there are now three additional youngsters creating a highly challenging household of children ranging in age from 5 to 18. Phil met fellow classmate, **Dennis Lytle** and his wife at an M.I.T. alumni dinner in Sao Paulo but we will have to await word from Dennis to catch up on his activities.

During Alumni Day in June, the class established its own luncheon table where I was joined by Katie and **Chuck Staples**, Charlotte and **Phil Richardson** and **Dick Sampson**. We heard the description of gifts to the Institute through the Alumni Fund and noted the fine results of our class's efforts as led by **Ed Safran**, our Class Agent.

Unfortunately in closing this column I must note the passing of two of our classmates, **Paul Lam** of Hong Kong died this spring as did **Gerald Clemmer** of West Chester, Penn. Our deepest sympathies to the families of our fellow '59ers.

Until next month, and on behalf of **Phil Richardson**, 180 Riverside Dr., New York, N. Y. 10024; **John Amrein**, 770 Greenwood Ave., Glencoe, Ill. 60022; **Adul Pinsuvana**, 49 Seri Rd., Seri Village, Hua Mark, Bangkok, Thailand; and **Bob Muh**, 907 Chantilly Rd., Los Angeles, Calif. 90024; this is **Allan Bufferd**, Secretary, 8 Whitney Rd., Newtonville, Mass. 02160, repeating our erstwhile phrase, — "It only takes a few minutes to drop a note."

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Several members of the class report recent, continuing, or upcoming assignments outside the U.S. in industry, education, and the military. **David Kellermann** is Product Marketing Manager in the inorganics and metals department of Dow Chemical Europe in Horgen, Switzerland. He is vice president of the M.I.T. Club of Switzerland, as well as secretary and newsletter editor of the American Club of Zurich. David and his wife, Wilhelmina, have two children, Anastasia, 7, and Laurence, 5. . . . **Varadachari Sadagopan** is beginning a two-year stint in Stuttgart as technical assistant to the director of research and development coordination of I.B.M. Laboratories in Europe. . . . **John Moore** is Chairman of the Department of Geology at Carleton University in Ottawa. From 1972 to 1974, he was engaged in a mapping project in southwest Ethiopia for the Canadian International Development Agency.

Sanford Miller recently was promoted to Professor of Mathematics at the State University of New York, Brockport. When last heard from, Sanford was headed for a summer at Babes-Bolyai University in Romania under a Fulbright Advanced Research Award. . . . **Clyde Reedy** is in his third year as Director of Facilities Engineering at Fort Benjamin Harrison, Ind., and he expects his next assignment to be overseas. During his present assignment, he has received the meritorious service medal and a Department of the Army certificate of achievement. Clyde also indicates that his son, Mark, was 20 months old (in April).

Llewellyn Bolton has been named Vice President of Zaldastani Associates, Inc., a structural engineering firm in Boston. He has been a manager and associate with the company since 1962, overseeing the construction of many projects, including the Logan Airport control tower and international terminal. . . . **Joseph O'Connell** is engaged in business analysis for the Chemical Division of Kaiser Aluminum in California. . . . **Morris Salame** is manager of container development at Monsanto in Bloomfield, Conn., and he is continuing work in polymer research. He represented Monsanto at the first North American Chemical Congress in Mexico City and was chairman of the Barrier Polymer Symposium at the centennial meeting of the American Chemical Society. . . . **Walt Niessen** has moved from Pennsylvania to become director of air quality and hazardous waste management with Camp, Dresser and McKee, Inc., of Boston. . . . **James Nicholson** is vice president and co-founder of Lyne-Nicholson, Inc., a Boston area producer of surgical instrumentation. . . . **Deena Koniver** has worked at the National Center for Disease Control in Atlanta for over a year and has recently settled

in a brand new condominium house. Having "left the world of math and computers a few years ago for the world of administration and management," she comments, "maybe Tech was H . . . , but it sure helped me reach the beautiful, challenging, satisfying position I now hold."

The Hahnemann Medical College and Hospital of Philadelphia reports that **Robert Barnes** received the Doctor of Medicine degree and will complete an internal medicine residency at Abington Memorial Hospital. Robert also earned his M.S. and Ph.D. degrees at the University of Wisconsin. He and his wife, Virginia, have two children. . . . **Michael Rosner** is practicing internal medicine and endocrinology in Holyoke, Mass. Michael, Joan, and their three children live in South Hadley. . . . **Chris Sprague** is now professor of management information systems at Boston University's School of Management. . . . **Gordon Mutchler** is on the Rice University faculty and is working on medium energy nuclear physics. His wife, Lynne, is "big in women's activities," and their son, Andrew, recently became an 8-year-old.

This month's No-News-is-No-News Award goes to the alumnus who wrote, "As near as I can tell, my last information was never published. Perhaps you could look in your files and try again." Duly chastened, I looked in the files and found a brief note received in 1970. Now I am willing to print almost anything, even stale news, but six-year-old news is beyond "stale." So let me implore our anonymous classmate, as well as the rest of you, to take a few minutes and send me some current information. — **Robert F. Stengel**, Secretary, 152 Oxbow Rd., Wayland, Mass. 01778

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Welcome to the fall series of *Tech Review* notes. I have some pretty good notes with which to start the year and hope that I will hear from more of you as the year progresses.

Neil Doppelt was admitted to partnership at Arthur Anderson & Co. in September, 1975. His responsibilities at A.A. & Co. are in the Administrative Services Division (consulting) in Chicago. Neil joined A.A. & Co. in 1968, after four years at Exxon International. He transferred to Chicago in 1972. Neil and his wife, Elizabeth, have two children — Rachael and Adam. They are now living in Wilmette, Ill. . . . **Robert H. Armsby** has been elected an associate partner of Skidmore, Owings and Merrill. He is working at the San Fransisco office. . . . Since leaving M.I.T. as a Research Associate in July, 1975, **Earl Ruiter** has been employed at Cambridge Systematics, Inc., a transportation consulting firm. Until July, he was working in the San Fransisco Bay area. . . . **Arnold F. Stancell** was promoted to Vice President, Planning and Operations, Mobil Plastics Division. He was the first recipient of the Professional Achievement Award of the National Organization of Black Chemists and Chemical Engineers. . . . **Fran Bulandi** has received certification in industrial hygiene from the American Board of Industrial Hygienists. He is presently with E.R.T. in Concord, Mass., as an enviromental consultant. . . . **Bill Anderson** has been appointed Assistant Professor of Psychiatry at Harvard Medical School. He will also continue on the staff at Mass. General Hospital. . . . **Bill Mihaltse** moved to Davenport, Iowa, from Conn. He is still with the I.B.M. Corp., now as Senior Systems Engineer. Bill has two daughters — Elizabeth, 6, and Christina, 1. He says that he is looking forward to the leisurely life of the Midwest. . . . I saw **Jan Hyde** in New York at the offices of his new company, Fizor, Inc., where he serves as Executive Vice President. The firm specializes in the securing of mortgage financing for shopping center and other developers. Jan also visited Linda and me at our home in Palos Verdes. — **Jerry Katell**, Secretary, 7 Silverbit Ln., Rolling Hills Est., Calif. 90274

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August, 1976. My cup runneth over. The month of June brought two letters — real letters. In July I had a visit from a classmate. Also in July the deadline notice from the *Review* contained 23 — count 'em, 23 — envelope flaps and two press releases. All told I have first- and second-hand news about roughly 30 of you.

The first letter was from **Alan Marty**, who has left the Navy where he has been chief of thoracic surgery first at Port Hueneme and for the past year at Long Beach Naval Regional Medical Center. He will be starting private practice in thoracic and cardiac surgery in Portland, Ore., where his address will be: Portland Cardio-thoracic Clinic, P.C., Suite 242, 2800 N. Vancouver Ave., Portland, Ore. 97227. Since 1969 Alan has published over two dozen scientific articles and three dozen book reviews in his field. He has also obtained Board Certification in both general and thoracic surgery. Alan and his wife have one child, Victoria, born November 1, 1974.

Alan also reports sightings of two classmates whose names have not appeared in this space over the years. **John Lambert**, M.D., is now Assistant Professor of Cardiac Surgery at the University of Chicago. **Tony Weikel**, M.D., is finishing up a plastic surgery residency in Gainesville, Fla. He recently studied rhinoplastics, hand surgery, and French women in Paris. Alan reports that this is the first sighting of Tony since Vietnam.

After 13 years of silence (at least as far as *Technology Review* is concerned) **Phil Marcus** has come through with a letter. Phil stayed at the 'tute until 1965, receiving an S.M. (sado-masochist?) in electrical engineering, and two days later married the former Marilyn Purpel of Cambridge (Simmons, '64). Phil next traveled to Hampton, Va., where he taught for a year at Hampton Institute. Then it was on to Baltimore, where he spent a year in graduate biophysics at Johns Hopkins. Following that Phil taught for three years at Towson State College in suburban Baltimore. In the final year of his teaching, 1970, the Marcus' son, Gary, was born.

In late July, 1970, long after the last date to register for the Law School Aptitude Test, Phil decided he would like to go to law school, talked the proctor into letting him take the "law boards," and was admitted to the University of Maryland Law School in September, 1970; received his J.D. in June, 1973. While a student he spent two years as an intern in the Legal Aid Bureau. Phil was admitted to the Maryland bar in December, 1973, and since that time has been engaged in the general practice of law in a small firm in Baltimore. On July 1, 1976, he became a partner in the firm of Armor and Marcus.

Phil's wife, Marilyn, is Maryland field coordinator of the Social Research Center of the University of Michigan, directing a variety of attitude and opinion surveys. In 1975 Phil was treasurer for a candidate for Baltimore City Council, and expects to continue his activity in electoral politics, although he has no plans to become a candidate himself.

Over the July 4th weekend Barbara and I had a visit from **Bjorn Conrad** and his three daughters, Danielle, 8, Kiri, 6, and Alexis, 4. My goodness, those three girls are growing up. Bjorn and I used to be neighbors across the street from each other in Menlo Park, Calif., and I remember when Danielle was born. She and my younger daughter, Laura, were best friends for several years. Bjorn is still living in Portola Valley and working at Stanford Research Institute with Bob Ratner, '64, who is Director of the newly-created Transportation Center at S.R.I.

Bjorn also furnished me with some information about a few other classmates he has seen or been in contact with recently. **Paul Abramson** is working in Cambridge for the Transportation Systems Center (a part of D.O.T.). Ann and **Ron Matlin** are living in Lexington, Mass., and back-packing is a favorite activity. **Ted Cohn**, recently married, is still at Berkeley in the School of Optometry. Bjorn also told me that after a chemistry degree from M.I.T. and a degree from the Harvard Business School, **Bernie Hopp** is now in the cosmetic business, traveling all over the world in his business activities.

Thanks to Alan, Phil, and Bjorn for the letters and first-hand information for this space. And may I urge those of you who do put pencil to paper every now and then to write not only about yourselves but also about some of your less communicative classmates.

A press release reports that Professor **John Prussing** has been named to a revolving deanship in the College of Engineering at the University of Illinois at Urbana-Champaign. John has been on the aeronautical and astronautical engineering faculty there since 1969. His interests are in the area of space mechanics; he started out on the M.I.T. Instrumentation Laboratory technical staff and later was on the Experimental Astronomy Laboratory staff. Subsequently John went to the University of California at San Diego, where he was Assistant Research Engineer and lecturer and also taught courses at General Dynamics-Corvair. John and his wife and two daughters live in Urbana.

Running out of space, so I'll hold over some news until next month. Some of you may be reading about things you did last spring in the December issue, but don't let that discourage you — I've published older news in this column. Have a happy Thanksgiving. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, Calif., 92715

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Greetings '64! Wow! What a deluge since last issue. Three class heroes and at least two dozen other news items. That's enough to spread around and keep us warm for the winter; so if you don't see yourself in this issue, then you're in the next one. And keep those letters coming, you class heroes.

Ron Gilman came through as a class hero, especially because he remembered the many times he had a news drought when he was our class secretary. Ron has become President of the Tennessee Bar Association's Young Lawyer group and also a member of the T.B.A.'s Board of Governors. He, wife Betsy and their two girls are all fine. They took a vacation work-break to the American Bar Association Convention this past summer in Atlanta.

And we have heard officially from the **Mike Monslers**. They're now living in the Oakland Hills area near San Francisco, with a view of the bay from their "beautiful wood and glass contemporary house." Their new address is 2061 Manzanita Dr., Oakland, Calif. 96411; (415) 339-8704. Mike is now Manager of Advanced Systems at Teknetron in Berkeley, Calif. Their family really seems to be growing up, as it must seem to many of us. Their children are both in school — Eric in the second grade and Kari in Kindergarten. Please come and help warm our new house."

The third class hero is Judie **Steelman** (Mrs. **David G.**). That's what we need — more spouses to write us news! Judie writes that they went to the wedding of **Richard Lipes** and Louise Kirkbride on June 5, 1976 at her parent's home in Mission Hills, Calif. At the reception the Steelmans met and visited with other M.I.T. grads: Penny and **Paul Holland** and Bob Wiley, '66, and his wife. Paul is in the food business. Bob is an engineer. He and his wife are expecting their second child this fall. The Steelmans are expecting another child in November, which will increase the family to three. They have two sons — Geoffrey, 4 and Craig, 2. David worked as an engineer in various aerospace jobs until his father's death in 1971. At that time he and his family returned to Oklahoma City to run the family's oil salvage business, The Parawax Co. Thank you all you class heroes. How about lots more of you writing. Our address is right at the bottom of this column.

Now to you classmates who remembered the M.I.T. alumni fund and also took time to jot down a few ramblings about yourselves: Having completed a five-year assignment, introducing Schottky barrier contact technology into Western Electric integrated circuit manufacture in Allentown, Penn., **John Andrews** has now returned to Bell Labs in Murray Hill, N.J., to begin work on solid state memory development. . . . **James Bradley** writes that "my biggest event of recent

years is that I've committed my life to Jesus Christ. As a result, I've changed a lot. Much of my insecurity and striving to be accepted are gone, although I still need to grow in this area." James is married, has two children and is at present teaching at Roberts Wesleyan, a small Christian College outside Rochester, N.Y. . . . **Tom Cheek**, his wife Susan and two sons are enjoying the great Northwest, where Tom is busy building computer display systems for TEKTRONIX.

Another classmate who's working for Bell Labs is **D.H. Cortelyou**. He's been there since his master's in electrical engineering in '65. He and his wife Carol just had their first child, a boy born in February. . . . **Michael Horter** writes that he is President-Elect, Lehigh Valley Section of the A.S.C.E. . . . Since last December, **Douglas Hoylman** has been Assistant Actuary for Research at Government Employees Insurance Co., which is located just outside Washington, D.C.

Another classmate coming to the Washington area is **Marlene L. H. Jorris (Hiller)**. Dr. Jorris is in surgical training from July '76 — July '77; then she is on to neurosurgery. She has written three chapters for the Navy Underwater Engineering-Medical Handbook. Marlene received her M.D. degree in May, 1975, after which she spent a year in internal medicine training. . . . **Eugene Glenn Merrill** is still in research at University College in London. He's recently divorced and has taken up motorcycle racing. . . . The principal bassoon with the Minnesota Orchestra is **John W. Miller. . . . Sylvia and Jerry Weiner** took a worldwide vacation this year: first one week in Peru and then a week in Israel.

Some good news has resulted from our move to the Washington area last year. I was recently promoted to the position of A.T.E. Technical Director in Mantech Systems; our activity provides engineering and management consulting services to the A.T.E. (Automatic Test Equipment) office in Headquarters Naval Material Command. On the personal side, in June Marlene and I shared a beautiful Tenth Anniversary in Bermuda, the scene of our honeymoon, and we were met there by the couple we honeymooned with and some other friends. (Our boys, George (7) and Lewis (4), were babysat by their grandparents.) During July, we occupied our "new" (for us) home. So far, everything about it has turned out well. We have ample space for visitors and guests; so please call when you're in the area.

Keep up the letters — it's great to hear from you. Keep the Technology Fund envelopes coming, too; it really did my heart good to see two dozen at once. Enjoy, God Bless, and KEEP WRITING! — **Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, Md., 20854; 301-299-3455 (home); 703-521-5955 (business — one mile from Washington National Airport)

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The long hiatus since the last issue has brought many notes and news clippings, so this will be a larger column than usual. **Dennis Bekeny** passed on the word that **Gene B. Chase** is head of the Math Department at Messiah College in Grantham, Penn. . . . **Steve Deutsch** has joined the Boston law firm of Foley, Hoag and Eliot; Steve and Karen have bought a house in Arlington. . . . **George McQuilken** has been Editor of the *IBM Systems Journal* for over two years and invites constructive criticism from any alums who read that journal. . . . **Don Coulter** has spent the last four years managing the construction of a new international airport for Rio de Janeiro, Brazil. . . . **Bill Mooseker** has returned to John Graham & Co. as a senior structural engineer. . . . **Jarrod Wilcox** has set up a management consulting firm, Advantage Group, to "assist corporations in developing business strategies." . . . **Donald Kutyna** has become Assistant Deputy for security assistance programs, U.S.A.F. Electronics Systems Division, Hanscom A.F.B. . . . **Remi Renard** is staff chemist at the Bayway Chemical Plant in Linden, N.J., of Exxon.

Jim Hester continues to do health systems research with the Kaiser Foundation Health Plan in Los Angeles; Jim has "a new wife, Shar, and a new house." . . . **Myron Weber** is also newly married, to Kay Ruth Siegel, and is now on the Business Faculty of the University of Calgary in Calgary, Alberta, Canada. . . . **Andrew Harris** received an M.B.A. from Northeastern this past June. . . . **David Cook** now has two children, Rebecca, 4, and Amy Ruth, 1.

On the travel front, Pam and **Mark Hanson** joined the M.I.T. Quarter Century Club for a trip to Copenhagen in June, and **Ralph Cicerone** sent a postcard from Novosibirsk, Siberia. Ralph was "11 time zones east of Boston" as a U.S. delegate to a Bilateral Agreement with the U.S.S.R. to do research on atmospheric pollution.

Steve Dangel, responding to **Ron Brinkerhoff**'s query in the March-April issue, notes that the best of his reunion photos were printed on the covers of the 10th Reunion Booklet. . . . **Harry** and **Barbara Vickers**, both '65ers, note that 1976 has been a happy year, with the arrival of William Joseph and a move to their new home in Sudbury. . . . Gloria and **Jim Sprinkle** and their son David, are enjoying Austin, where Jim is assistant professor in geological sciences at the University of Texas. One of Jim's research papers dealt with the discovery of fossilized eggs in a 325-million-year-old extinct echinoderm.

Allan Smith is a professor at Drexel. . . . **Stanley Brown** is on the Bioengineering Faculty at Dartmouth Medical School, studying fracture healing in animals. . . . **Edward Palo** is with MITRE, recently named leader of the Signal Processing Techniques Group.

John Kassakian has been named the first holder of the Carl Soderberg Professorship in Power Engineering at M.I.T. Congratulations!

On the read it and turn green with envy front was an article in *Empire* magazine of April 4, 1976 about Susan and **Stephen Schutz**. Steve followed his physics degree at Tech with a Ph.D. in theoretical physics from Princeton. Susan and Stephen are now co-owners of Blue Mountain Arts, Inc., of Boulder, Colorado. The firm publishes cards, prints, posters, calenders and books from the combined talents of Susan's poems and Steve's illustrations. Their company expects to sell over $7 million of these products in 1976. The Schutzes are the proud parents of Jared, age 1.

We must note sadly the death of **Frederic W. Reuter III** in February, 1976. I also received a telephone call noting the death of David Hahn, who entered with the Class of 1965.

Keep writing, and let's see if we can come up with a column this long without a three month hiatus for news. — **Edward P. Hoffer**, Secretary, 12 Upland Rd., Wellesley, Mass. 02181

Arthur Fiedler is introduced at a reception following M.I.T. night at the San Francisco Pops during July which drew about 300 alumni and their guests. Behind Mr. Fiedler is Perry Seal, '65, Vice President of the M.I.T. Club of Northern California, who arranged the evening. (Photo: Robert Ramers)

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The Tenth Reunion was a super weekend; attended by over 60 members of the class plus spouses and children. We had a cocktail party Friday evening, June 4, in McCormick Hall. Many class members were suprisingly easy to recognize. However, the growth of moustaches and stomachs often formed effective disguises. Saturday was spent around Boston, including a show at the New England Aquarium. Saturday night we had cocktails and dinner at the new M.I.T. Historical Collection, which is well worth a trip to Cambridge. The weekend was topped off with a "blast" featuring oldies by the "Invaders," featuring **Pete Blankenship** and **Woody Stoddard**. Woody recently completed his Ph.D. in Ocean Engineering at the University of Massachusetts and writes that his research concerns wind generators and solar energy. It was good to renew old acquaintances. I will bring you up to date with reunion attendees in the next issue.

Paul Eckstein and **Mike Adler** both ask if the Class Secretary is functioning. I think so. . . . **Tad Whited** graduated from medical school in May and is beginning residency in family practice at Bexar County Hospital in San Antonio, Texas. His wife, Cheryl, will begin law school in September. They have a daughter, Jennifer, now 3. . . . **Henry Goldman** has been practicing law for almost three years with Sachs, Greenebaum and Tayler, in Washington, D.C. He has been married for two years to the former Susan Opdyke. . . . Others in Washington include **Ed Notzon**, who is the Director of the Monitoring and Data Support Division of the U.S.E.P.A., and **John Freeman**, who is serving as the Deputy Assistant Administrator for Energy Projects at the Federal Energy Administration.

Educational news as follows: **John Sheats** is an Associate Professor of Chemistry at Rider College in Lawrenceville, N.J. . . . **Ted Rhyne** has just finished his Sc.D. in electrical engineering at the Institute and writes that after two years in industry and an additional two in the army, "It's been a long haul to the Sc.D.!" . . . **Charles Erdelyi** just finished a year of graduate work at the University of Vermont, in the LSI Institute, a program for I.B.M. Engineers.

Ken Baxter, his wife, Rita, and two children (with a third due in October), live in Manassas, Va., where he is manager of a digital signal processor development group for I.B.M. . . . **Terry May** recently took a new job as General Manager of Vortex Engineering. He and his wife have one son, and as I write this column, they are expecting another child in August. . . . **Don Hess** is Co-Founder, Vice Presidentn and Secretary/Treasurer of Amherst Systems, Inc., a computer systems engineering concern founded in June, 1975. Don and Vicky had a daughter, Laura Ann, in February. . . . **Bob Fila** is dealing in land development and real estate for a subsidiary of Exxon in Houston, Tex. The Filas had their second child in April. . . . **Bill Dietrich** is here in New York as an Assistant Vice President for First Boston Corp. Bill is married to the ftrmer Clare Chapman of Baltimore, and they have two children. . . . **John Stampfel** inquires if the rest of '66 is dead, or just the Secretary? John and Priscilla have moved out of an apartment into a home of their own. John is with Bell Labs.

Marion Wood reports a baby girl, Carrie, on May 9, 1975. . . . **Joe Sullivan** recently moved from Pittsburgh to Hanover, Penn., to take a position as General Plant Manager of UTZ, Inc., a food processing company, where he is in charge

of manufacturing, plant engineering, and quality control. . . . **Richard L. Cutter** has passed the National Examination for Registration as an Architect. . . . I received that bit of news from the *Town Crier* of Wayland, Mass. . . . **George Bourrie** is working for Education Computer Corp. designing computer-controlled simulators for training in the Armed Forces. . . . **Ray Poust** writes that he is currently manager of Computer Systems Development for the Pulp and Paper Group at Crown Zellerbach Corp. in San Francisco. . . . **Steve Lawrence** is currently in New York City and is a vice president with Rosenkrantz, Ehremkrantz, Lyon and Ross, where he manages personal assets and discretionary option trading accounts. . . . **Pete Lobban** will start with Varian (I assume in the Palo Alto area) where he will be putting microprocessors into their instrument line.

Joe Bravman recently became Manager of Electronic Systems at Fairchild Space and Electronics Co. in Germantown, Md. Received a note from **W. Chang** saying he is presently a senior member of scientific staff for BNR, Inc. . . . **Gordon Olson** graduated from Harvard Business School in June, 1975, and is working for General Electric's Corporate Consulting Service in Schenectady, N.Y. . . . **Charles Howard** writes that he's been in private practice as a consulting engineer specializing in water resource management problems in Canada and the U.S. He indicates that **Uri Shamir** and **Wayne Huber** will be with him in Winnipeg, Canada, for about six weeks this summer. . . . **Dan Smith** is in Norwood, where the Smiths have a second child, Libbie. He would appreciate hearing from old Burton Fine Fifthers (617-742-3140, x260).

Saul Mooallem and his wife, Susan, have a daughter, Rebecca, who was born November 17, 1975, and says that Rebecca already owns an M.I.T. sweatshirt. . . . **Mike Marx** writes as follows: "Susan and I have become firmly entrenched in Old New England. We are living happily in Acton, Mass., with our three children: Jennifer, 6; Amy, 4; and Daniel, 1. Professionally, the transition from engineering to management consulting has been very rewarding. I am now a Vice President and principal of Technical Marketing Assoc., Inc., in Concord, Mass. T.M.A. is a specialized management consulting firm assisting manufacturers of highly engineered products in the identification and exploitation of business opportunities." . . . **John Masters** is a violin maker and repairman. He has been self-employed since 1972. . . . **Peter Wolfe** wrote that he eats, sleeps, works, and rides his motorcycle. But he didn't indicate where this is all happening.

That ends the back-log of notes. Next month I will write more reunion news. I promise to keep the column going as long as you keep the letters coming. — **Paul Rudovsky**, Secretary, 340 East 64th St., Apt. 10B, New York, N.Y. 10021

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Mike Scott, who is practicing law in Los Angeles, writes: "Our law firm is expanding and will be moving to new quarters. I have been designing a computer system which will significantly automate our offices. I have been appointed Member of the California State Bar Committee on Computers and Law and am Chairman of the Subcommittee on Computer Usage which is evaluating the current and potential use of computers in California law firms. These committees hope to create interest by computer firms in the virtually-untapped legal field. Last fall I began teaching at Southwestern University School of Law in Los Angeles. I am endeavoring to develop a course in Technology and the Law for spring, 1977." Mike's wife, Carol, is his secretary and also studies interior design at U.C.L.A. They are presently apartment dwellers but are looking for a home in Los Angeles. . . . **Steve Marcus** has become a member of the law firm of Greenberg, Bernhard, Weiss & Karma in Los Angeles. . . . **Steve Schroeder** is Chief of the Legal Review Section of E.P.A. Upon graduation he worked on the Apollo Lunar Module for Grumman Aircraft. He then transferred to Draper Laboratory where he was responsible for briefing the Apollo 13 and 14 crews on the descent and rendezvous programs. Steve has a degree from Harvard Law School. . . . **Greg Wight** is still with the Connecticut Department of Environmental Protection even though the environmental movement in Connecticut appears to be losing momentum. . . . **Ed Lamon** is a pediatrician in the Family Health Clinic in Albuquerque. . . . **George Howison**, an audit manager with Arthur Andersen & Co. in Phoenix, is the father of Gretchen, 7, and Derek, 6. . . . After a nine-year saga too complex to recount, **Burns Woodward** is getting together his practice and research in psychiatry in the Cambridge and Newton areas. — **Jim Swanson**, Secretary, 669 Glen Rd., Danville, Calif. 94526

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Welcome back after a long summer. We hope everyone had a good time and we're looking forward to finding out about what people did out of the ordinary. . . . Speaking about welcomes, **Fritz Efaw** certainly deserves mention this month for a rather dramatic return. Fritz had been working in England as a computer analyst while under indictment in the U.S. on a charge of refusing to report for induction. He returned as an alternate delegate to the Democratic National Convention representing the Democrats Abroad. His name was placed in nomination for Vice President and he presented his arguments in favor of amnesty for all war resisters before a national TV audience. He is now free on bond awaiting possible trial in Oklahoma City. . . . In January, 1975, **Steve Reimers** was married to Jeanne Woodlee of Beeville, Texas. Jeanne was a widow with a 5-year-old daughter so Steve is "now a husband, father, and member of the hopefully happy house owners club." . . . **Wilson Dillaway** reports the birth of a son, Robin, on July 11, 1975.

We have three degrees to report this month. **Gary Ender** has finished an M.S. in Agricultural Economics and hopes to do research overseas for a doctorate. **Bob Haslam** graduated from Hastings Law School in June and is working at Heller, Ehrman, White, and McAuliffe in San Francisco. Finally, **Dave Cahn** finished a Ph.D. from Berkeley in bioengineering with a thesis in artificial intelligence and pattern recognition. He still lives in Berkeley and splits his time between "puttering around" at Stanford Research Institute and sailing small boats on the bay.

Harry Goldmark writes that he is a resident in orthopedic surgery at the Hospital for Special Surgery in New York. His brother, **George**, is in the same program. They see **Art Klein**, who is a Professor of Pediatric Cardiology at N.Y. Hospital. . . . Our world traveler award this month must go to **Ken Morse** who has returned from his seventh trip to China. He reports, "each time the famous hospitality and warmth of the Chinese people is more and more striking." . . . **Sherman Hanna** is an assistant professor in the Department of Family and Child Development at Auburn University.

Several notes this month from people in various parts of the computer business. In Beantown, **Armen Varteressian** is working as supervisor of software technical writing at Digital Equipment Corp. and works from time to time with **Karen Brothers** and **Louise Silver**. In Phoenix, **Richard Keys** is working on the design of interactive computer systems for Honeywell. His daughter, Christine, is now almost 2 years old. Finally, in California, **Peter Groot** is now programming medium-size multiprocessing systems but expects to work soon on small real-time systems for flight simulators.

Bob Phair has finished his coursework and passed the prelims. His experiments are designed to investigate the control of blood flow to skeletal muscles and are going so well that he thinks his doctorate in physiology is "visible just over the horizon." His wife Judy was recently promoted to editor of internal publications at the University of Michigan so they will probably stay at Ann Arbor until 1978. . . . **Rick Rudy** has quit General Electric after many years and is working as senior manufacturing engineer for Spectra Physics. As always, he is spending lots of time with the Gilbert and Sullivan Society of San Jose, where he has the lead role in the current production of *Patience* and will be director for the production of *The Gondoliers*. . . . **Mike Yokell** has an N.S.F. energy-related-postdoc at Berkeley for this academic year.

In Cincinnati, **Paul Freshwater** is Assistant to the Vice President of Packaging, Soap and Detergent Division, Procter and Gamble, and is also President of the Kennedy Heights Community Council. . . . **John Seaquist** has been working at TRW for four years and is now project manager in the Security Systems Office doing systems analysis and model building. Since graduation he has received an M.S. in management science and an M.B.A. from U.S.C. John, his wife Chris, and their sons Derek, 3, and Bryan, 1, all enjoy living in Orange County, Calif. . . . **Richard Griggs** has completed production of a low-budget film entitled "Off the Wall," which was shot primarily in the San Francisco bay area. He currently is studying computer music and composing for the player piano with a PDP-11. . . . **Ellen (Colmer) Domb** has finished a postdoc at the University of Nebraska and is starting a "real job" at Harvey Mudd College. She is looking forward to meeting classmates in the L.A. area.

David Ellis has moved from his position as an attorney for RCA Global Communications in New York to RCA American Communications, a new domestic satellite communications subsidiary of RCA, in Piscataway, N.J. He has moved to New Brunswick with his wife, Sue, who recently received her Ph.D. in psychology and plans to practice in the area. . . . That's all for this month. Looking forward to hearing from you. — **Gail** and **Mike Marcus**, Secretaries, 2207 Reddfield Dr., Falls Church, Va. 22043

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Melvyn Basan is enjoying himself after 12 months in Chicago and 11 months working for the U.S.G. He was admitted to the Illinois Bar last year. As class agent he wishes to inform all contributors from the class who have not yet received thank you's, the notes should be in the mail soon. . . . **W. Basner** is designing heat recovery steam generators for G.E. in Lynn, Mass. His wife, Meg, is a social worker at the Hebrew Rehabilitation Center for the Aged in West Roxbury, Mass. Last August they attended **William P. Bengen**'s wedding in Long Island, N.Y., and saw **Wayne Oehrli** there. . . . William P. Bengen is working on a sci-fi novel. He married the former Joyce Gans, a high school teacher, on August 23, 1975, honeymooned in Bermuda, bought a house in Smithtown and is now raising vegetables. . . . **Denis A. Bovin** and Terry announce the birth of their daughter Michelle on May 26. . . . **Paul J. Channell** received his Ph.D. in theoretical physics from U.C.-Berkeley last November. He spent a year postdoc at L.B.L. in controlled fusion. He has accepted a research associate position at the Institute for Advanced Studies in Princeton, is married, and expects a child in the autumn.

Paul W. Chin, Jr., is trying to earn an M.B.A. from Stanford in one year. He will be with the First National City Bank of New York in Athens, Greece, at the Mena headquarters co-ordinating Middle East and North African operations commencing in June, 1976. . . . **David R. Chittick** has been appointed Director of Operations for Western Electric's Bell Sales Division. He, his wife, and two children live in Basking Ridge, N.J. . . . **Francisco Coronel** received an M.B.A. from Columbia in 1971, then worked for the University of Quebec, and later for Sir George Williams University of Memorial University. He has recently passed his prelims for a Ph.D. in Management at Purdue. . . . **M. R. Dohan** has been promoted to Associate Professor of Economics with tenure at Queens College at Flushing, N.Y.

Ron Felsenstein has been working for HP Santa Clara in digital design since graduation. He works with microwave counters, laser interferometers and logic test products. His and Linda's son Andy is 1.7 years old at this writing. . . . **David**

L. Felten completed doctoral degrees in medicine and the philosophy of anatomy in 1973. For at least the last two years he has been teaching a brain sciences course to medical students at the Indiana University School of Medicine, and has been investigating the role of disordered neurotransmitter activity in neurological disease. . . . **Ben Franklin** and his wife Nancy are enjoying California. After earning an M.B.A. from Harvard in 1975, Ben took a job working as a microcomputer product manager at Intel Corporation.

Jonathan A. Frost married Kathleen Ann Brennan on January 3, 1976. He is working at SRI in optical data processing and has been flying around California in a small plane. . . . **Leo Geoffrion** is teaching reading at U.N.H. and enjoying rural New England living. . . . **Robert A. Gladstone** has lived in the Washington area for 5.5 years and presently resides in Reston, Va. Since February, 1975, he has been the Northeastern District Manager for the Reinforced Earth Co. (Washington, D.C.) in charge of marketing and project development primarily in New England and Middle Atlantic regions. On April 3, 1976, his wife Jackie gave birth to their first child, Sharon.

Frank M. Guillot is currently working as an architectural designer in Burlington. . . . **Ernest C. Heimberg, Jr.**, is nuclear systems engineer at Babcock-Brown Boveri Reaktor GMBH in Mannheim, West Germany, as part of a Stone and Webster project management team assisting in the design and construction of the Muelheim-Kaerlich Nuclear Plant. . . . **Randall J. Hekman** is a Probate-Juvenile Court Judge in Grand Rapids. He is the father of four daughters. . . . **David A. Herrelko** and his wife Janet are getting settled with their daughter Kathy who was 8 months old in June, 1976. David just completed his Ph.D. in Engineering at U.C.L.A. and is now the Chief, Data Processing Branch, Joint Tactical Information Distribution System at the Joint Program Office, Hanscom A.F.B., Mass. He reports that: **Henry Haller** married the former Jean Coram of North Andover, Mass., in May, 1976. At the wedding in Pittsburgh were David, his wife Jan, **Chuck** and Sandy **Sieber**, Joel Wolf, '68, and Steve Ostrach, '68. Hal does cryogenic research for Westinghouse. Joel teaches math at Harvard, Steve practices law in Washington, D.C. Joel and his wife Cathy have a new baby girl, Erica. The same group also met near Mt. Vernon for Steve's wedding to the former Linda Eisenmann of D.C.

Dave also reports that **Ron Bagley** and his wife Ellen have moved to Dayton, Ohio, where he is pursuing a Ph.D. at the Air Force Institute of Technology. . . . **Tom Imrich** and his wife Dee have moved ot Reston, Va., and Tom works for the F.A.A. . . . Chuck Sieber, his wife Sandy and their daughter Kathy live in Sterling, Va., and Chuck works for the Naval Electronic Systems Command. . . . Dave ran into **Amy Fujimoto** at the Hughes Aircraft Co., Ground Systems Group, in Fullerton, Calif. She is developing real-time airborne software for a command, control, and communications (C^3) program.

Rick W. Hessdorfer is working for the German government in Gemany. . . . **D. Hiatt** has been assigned to the U.N. as a special consultant by the U.S. Dept. of Transportation. The assignment included four months in Geneva, Switzerland, during skiing season. . . . **Gary B. Hirsch** coauthored *The Persistent Poppy* which is about heroin addiction. . . . **Charles T. Hudson** was blessed with a daughter, Heather Caryl, on August 13, 1975. He is working for Comshare, Inc. in Ann Arbor, Mich., on the design and implementation of specialty time-sharing software. . . . **J.W. Jurgens** is an independent consultant to U.S. firms who wish to expand into Europe by aquisition, other direct investment, or by export. He specializes in chemicals, industrial goods, and industry market research. He is also selling shares in U.S. real estate to German investors through a U.S. company — International Real Capital, Inc. . . . **Albert H. Kauffman** is working as an attorney on civil rights litigation in employment and voting rights for the Mexican American Legal Defense Fund in San Antonio, Tex. He asks classmates to look him up in San Antonio.

James Kornberg received his Sc.D. in environmental engineering at Harvard in 1974 and his M.D. from Dartmouth in 1976. This coming year Jim and his wife Sally will be in Cooperstown, N.Y., where Jim will be a resident at Mary Imogene Bassett Hospital, a Columbia University teaching hospital. He will be working in neurology and psychiatry but may return to environmental engineering and medicine after receiving his permanent medical license. . . . **Norman J. Landis** received his Ph.D. in computer science from Stony Brook last summer and is living in Hackensack, N.J., and teaching at Fairleigh Dickinson. . . . **Stephen T. Lee** is with Systems Control, Inc. in Palo Alto, Calif., and is presently assigned to a Canadian government project in Montreal to study the economics of developing tidal power in the Bay of Fundy. He is a senior engineer in the energy sector. . . . **Henry I. Levine** married Jo Ann Berlin on May 28, 1976. Jo Ann will be a Fellow in Neonatology and Henry will be a second-year House Officer in Pediatrics at the Children's Hospital of Buffalo this autumn. Their honeymoon was in Greece, Miami Beach, and Niagara Falls.

George K. Lewis received his Ph.D. in bio-medical engineering from W.P.I. in 1974. He is presently a senior research engineer in cardiology for G.D.Searle Co., and lives with his wife, Diane, and their 19-month-old daughter, Jennifer, in Arlington Heights, Ill. They are expecting a second child in December. . . . **Doyle Little** is in Ft. Worth, Tex. He is still trying to get more oil and gas out of holes in the ground and is of the opinion that "most people don't seem to appreciate our effort." . . . **James F. Lynch** is married, working toward his Ph.D., and living in Colorado. . . . **Kendall C. Marr** and his wife Lianne became the parents of their first child, Jonathan, on May 25, 1976. He has completed his first year of an oncology fellowship at the National Cancer Insitute in Bethesda, Md. He plans one more year at the N.I.H. and then a two-year cardiology fellowship at Cedars-Sinai Medical Center in Los Angeles.

Steve Nadeau is finishing his third year at the University of Florida Medical School. . . . **Robert D. Nicholson** has been promoted to manager of Servovalve Engineering at Pegasus in Troy, Mich. . . . **Stephen Nord** completed an internship in Internal Medicine at the Billings Hospital in June, 1976. He will then have two more years of residency. He and his wife, Susan, and their daughter, Jessica, have adjusted to city life but look forward to returning to California. . . . **Richard Partridge** still works for I.B.M. in Poughkeepsie, N.Y., as an engineer in the large scale processor group. He married Evelyn Miller on July 3, 1976. . . . **Bill Luken** and his wife, Marj, will be heading for Duke University where Bill assumes a faculty position. . . . **Jeffrey S. Passel** married Ellen Solomon on February 29, 1976. He received his Ph.D. in demography from Johns Hopkins on May 21, 1976. He has been working at the Census Bureau in Washington, D.C., for two years and reports that **Burt Barnow** and his wife Renee live around the corner from him. . . . **Jerry Raines**, President of Technovators, Inc. (electromagnetic and communications engineers), reports that his firm received its second contract from N.A.S.A. within 12 months. This contract, won by competitive bid, is to evaluate the electromagnetic wave energy conversion concept. . . . **Robert A. Sable** is finishing his internal medicine residency at Montefiore Hospital and will be doing a fellowship in gastroenterology at Metropolitan Hospital in New York City as of July 1, 1976. He asks anyone who has heard from **Stu Blickman** to send him Stu's address.

Richard Smith has not lived in interesting times this past year, thus avoiding an ancient curse; he surmises that next year he may or may not have news for publication. . . . **Dennis R. Spurgeon** has been named project manager, Light Water Reactor Fuel Preprocessing and Recycle Project Office as of April, 1976. Formerly he was Executive Assistant to the President of the General Atomic Company. . . . **Michael J. Underhill** has been promoted to Assistant Professor in Architecture at M.I.T. . . . **Peter E. Viemeister** has been elected chairman of the Empire State College Foundation. — **Peter Peckarsky**, Secretary, 950 25th St., N.W., Washington, D.C. 20037

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Hopefully, these recent columns will answer the inquiries of **Marinus C. Langeveld** and **Harvey S. Schultz**. More class news is welcomed from all.

After working for several years in California, **Sam Stroud** has completed his first year at Harvard Business School. Although his "attitudes" have swung full circle, Sam wants everybody to note his is still single.

Bruce Lautenschlager's family includes two daughters, Carol Ann and Susan Jean. Bruce has changed employers recently to Johnson Controls Co. in Milwaukee as a programmer. . . . **Robert Kattef**'s whole family is doing fine — first child, Joshua David, was born this spring. . . . "Big blue eyes" and a "beguiling smile" describes Laura, the baby daughter of Alice and **John Eichelberger**. . . . **David Thiel** and Marilyn also have a baby girl. . . . Daughter Deborah Ann has joined brother Michael in the family of **John Carroll**, who is still teaching psychology at Carnegie-Mellon. He is specializing in research on parole decisions.

The legal profession has claimed several classmates' energies. **Duane Shinnick** has had trouble breaking his M.I.T. habit of working hard in the District Attorney's office in San Diego. . . . Antitrust litigation is the focal point of **Ira Sacks**' "Big Apple" law firm practice. He and Lois have settled into their new house in Ardsley. . . . The Province of Ontario has two new M.I.T. members of the Bar. **John Morrissey** is practicing with Barrigar and Oyen. His practice is restricted to patents, trademarks, copyrights and industrial designs. **Fred Campling** indicated that the legal education process involved three years of school, one year of "articling," and a bar review course. Fred is now a law clerk for the Supreme Court of Ontario. . . . The study of law at the University of Detroit is the present occupation of **James Finder**, after three years at Honeywell, Inc. as a regional credit manager. James recently saw **Phil Byer**, who is teaching in civil engineering at the University of Toronto after receiving his Ph.D. from M.I.T. Phil's graduate studies focused upon evaluation of engineering systems. Sandy Schurer Byer (B.U., '71) is beginning a new career as a professional folk singer. They traveled through Europe last summer and invite everyone to visit Toronto.

The medical profession also has a strong contigent of classmates. **R.F. Geist** is at Boston City Hospital beginning his junior residency after finishing an internal medicine internship. . . . **Dean Roller** is currently the senior medical resident at the University of Pennsylvania hospital and is starting a fellowship in cardiology at the Yale University Medical Center. . . . For contrasts compare the practices of **Nick Escott** and **Jeffrey Weisel**. The former has a general practice in a "pulp and paper town" on the north shore of Lake Superior. The winters are long and cold, but filled with good skiing and snow-shoeing. The family, including daughters Vanessa and Julia, enjoy the beautiful forests. Jeffrey is in "smog-ridden L.A." working towards "life's supposed goals." However, he is finishing his residency in internal medicine "Hollwood style" in a new, large, private hospital. His wife, Kathie, is a graduate student at U.C.L.A. in psychiatric nursing.

Wesley Moore sent a letter to me on his "Guano Aeroplane and Zeppelin Works" letterhead. Evidently this firm, where Wesley is chief engineer, is producing 25 copies of a limited edition model airplane kit of an obscure Yugoslavian airplane. However, Boeing has been paying him on a somewhat more regular basis for trying to use a computer to design airplanes as opposed to analyzing them. The private pilot's license came through in November, but only two passengers have accompanied him on flights. Wesley included the following notes concerning classmates. **Marc Weinberg** finished his Air Force duties and works for Draper Labs. **Dave Hall** left Cal Tech with his Ph.D. and assumed a position at Einstein

The Class of '71 held their reunion picnic on the beach at Barnstable. (photo: Darrell J. King, '72)

in New York. **Dick Voss** disappeared into "his own lab" at I.B.M. after getting a Ph.D. at Berkeley. Coaching little league soccer — that is what **Jim Van Gaasbeek** does in Hurst, Tex., in addition to researching strange aeroelastic phenomena for Bell Helicopter. Ann is finishing law school.

Tim Gilmore did not discuss his relationship to the "pipeline," but has been working for five years with the Alaska Environmental Conservation Dept. One of these five was a year off to do extensive traveling with his spouse, Susan. Both desire to move to the "lower 48" to broaden their career bases. . . . The Navy took four years of **Mark Ketchen**'s life and he is now pursuing a Ph.D. in low temperature solid state physics at Berkeley. . . . **Anthony Picardi** wanted to correct some "garbles" in my June notes. The consulting firm that he formed with his graduate school adviser and several colleagues is continuing to analyze the water and power needs of Saudi Arabia. Evidently, Shirley's Ph.D. was more correctly involved with "Food Science and Technology."

Dave Erickson wanted to know what I was up to these days and I suppose the answer was in the several past issues. Dave didn't indicate his activities, but a letter may be coming forthwith. Gatsby, our dog, and Chivas Regal, our cat, are helping us remodel the den. Maggie and I are both enjoying tennis and the legal profession. — **Robert Vegeler**, Secretary, Kennerk, Dumas, Burke & Backs, 2120 Fort Wayne National Bank Bldg., Fort Wayne, Ind. 46802

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Our class is either becoming more affluent or just more responsive to the class solicitations; the comments on the backs of the donation letters are numerous this month.

Gary H. Lantner was graduated from Suffolk University Law School in February, took the Massachusetts bar exam, and was admitted to practice this June. He's going to attend the B.U. Graduate Tax Program for Lawyers in the fall. . . . **Hervey L. Sweetwood** was elected a city councilman of Delmar, Calif. . . . **Grethe Holby**'s life sounds exciting: "Having worked with the Laura Dean & Dance Co. and the Katherine Litz Dance Co., I will be touring in Europe this summer and fall with an experimental opera directed by Robert Wilson and composed by Philip Glass. I have also just completed choreographing a musical, 'Summer Snow,' which will have its world premiere in the Performing Arts Music Hall in Detroit."

Shari G. Kessler is now establishing the "By Arm and Leg Studio" to house photographs and photographics of South American and other images; it will sponsor special subject tours to South America. The first trip is to the Galapagos Islands in February or March, 1977. . . . **Earl Kessler** is now a self-help construction advisor working with the Foundation for Cooperative Housing in Washington, D.C. He is developing the low income shelter division of F.C.H. International Programs, focusing on housing problems of developing countries.

Jack M. Katz finished his internship in straight medicine at Presbyterian University Hospital and began a residency in radiology at Peter Bent Brigham Hospital on July 1. His address is 320 Commonwealth Ave., Apt. 11, Boston. . . . **John Stefano** is an opthamology resident at Beth Israel Medical Center in New York. . . . **William E. Giddens**, having completed a three year career with the Air Force at the Space and Missile Systems Organization in Los Angeles, is now in the plant engineering department of Charmin Paper Products Co., in Albany, Ga. . . . **Harriet (Burtch) Burris** writes, "I just received my M.D. from S.U.N.Y.-Upstate Medical Center. I start my family practice residency at St. Joseph's Hospital in Syracuse in July. I married John Burris November 30, 1974. He is a product engineer for Carrier Corp. and working on his bachelor's thesis for M.I.T." . . . **Charles F. Lanzillo, Jr.**, will begin opthamology residency at University Hospital, Boston, in July. He has a son, Charles Francis III, born December 15, 1975; has requested admission application to M.I.T. for Class of 1993.

Kenneth Vogel is now Assistant Professor in Economics at S.U.N.Y.-Buffalo after obtaining a J.D. and a Ph.D. in Policy Analysis at Penn. . . . **Carey Probst** was appointed Planning and Research Supervisor for Bliss and Laughlin Steel Co. in Harvey, Ill. The first child, Brian Patrick, was born February 12, 1976: 7 lbs., 2 oz. . . . **Sally Harvey** writes: "I am marrying Anthony D. Cortese (Tufts '68, M.S. '72, Ph.D. Harvard, '76) on August 29, 1976 in Cambridge. We plan to remain in Washington, working at E.P.A. for about a year. Then I hope to return to school when I figure out what to study." Congratulations, Sally!

Edward R. Mathews was appointed Director of the Transportation Test Center, Department of Transportation, Pueblo, Colo. . . . **Peter Stoll** moved to a house in Sunnyvale and continues to design a microprocessor for Intel. . . . **William J. Swedish** married Linda L. Griggs, daughter of Robert S. Griggs, '49, in June, 1974. They moved to D.C. that fall and bought a house a year later. William is with the MITRE Corp., studying air traffic control problems for the F.A.A. while Linda is with the Securities and Exchange Commission. . . . **N.D. de Pasquale** is Vice President, Tactical Weapons Systems. . . . **Nancy** and Don **Rosenfield**, '69, will be moving back to the Boston area this summer. Don will be working at Arthur D. Little and Nancy will be looking for a part-time programming job. Their daughter, Jennifer, will be 2 years old in August. . . . **Clifton K. Chang** was recently made a partner of Trammel Crow, a worldwide real estate developer, and is managing the company's sales and joint venture program.

Avi Ornstein is still a high school science teacher at Holy Cross High School, Waterbury, Conn., where he has started a service club, Ophelia, based on Alpha Phi Omega. In addition, he's a summer counselor at the Youth Conservation Corps camp in Meshomasic State Forest. . . . **David G. Alexander**: send the information about Japan; I'll make sure it gets in. . . . **F.A. Middleton** recently joined the Holding Company Planning Group at Studebaker-Worthington in New York. The group assists the chairman with mergers, acquisitions, and corporate strategic planning. . . . **David Curt Morris** just finished a year with Skidmore, Owings and Merrill, and spent three months in Algiers on a University Design Project. **Gerald Croan** and Sandi are living in York, Penn., and are the parents of a 9-month-old son, Adam. Gerald is Director of Juvenile Delinquency Planning for the Commonwealth of Pennsylvania.

Thomas F.J. Pipal married Diana Hall (M.S. from Northwestern in Industrial Engineering), and is Assistant Professor of Management at the University of Tulsa. He's trying to finish his dissertation on "Personality, creativity and team structure in high energy physics: a contingency analysis." . . . **Philippe E.G.L. Annez** was a planner in Saudi Arabia from 1971-72 for the Saudi government, in Indonesia from 1973-74 for the Belgian bilateral aid program, in Tunisia as a U.N.E.S.C.O. associate expert from 1974-75, and is now a Ph.D. candidate in the Department of Urban Studies and Planning at M.I.T. . . . **J.H. Peters** is President of a new corporation of consultants on health management systems. "Future open ended." He's involved in policy analysis and formulation, programming, program planning, and project design and evaluation at the local, state, regional, national, and international levels.

Kevin R. O'Brien is still programming in D.C. Recently he purchased a house in Arlington, which he shares with three others in my prayer community. He writes: "I prepared income taxes again this winter after teaching tax preparation last fall. Studying accounting in my spare time and have left the ranks of the taxpayers. God's been good to me!" . . . **Michael Titelbaum** has been at Digital Equipment. He and Barbara are expecting their first child in August. "Living in Stow is a far cry from Beacon Street." . . . **David M. Renton II** is with Helmsley-Spear in New York City. He has a new son, David M. Renton III. . . . After completing his medical internship at Georgetown in June, **Ken Gerber** is starting at the National Institute of Health in the Artificial Heart Program.

From **Ev Sinnett**: "I will be returning to Boston with my wife, Rachel, this fall after five years in San Diego. I'm finishing up a Ph.D. at Scripps Institute of Oceanography on the pulmonary circulation of seals, and will be working on a postdoctorate at the Harvard School of Public Health. Rachel will continue to support the family as a broker at the Boston Merrill Lynch office, and thats no bull!" . . . **Bob Wilson** is living in D.C. with his wife, Joanie, where he is an economist for the Justice Department. In his spare time, he moonlights as a locksmith and dabbles in the commodities market in potatoes.

Ed and Joyce Turner will be returning to Boston in January, when she will begin work on a Master's and Ed will begin an appointment as Assistant Professor of Astronomy at Harvard. . . . **Jay Delahanty** received his M.B.A. from Stanford this June. He is returning to work for the chemical management consulting section of Arthur D. Little, Inc., in Cambridge after working for the mechanical engineering section of A.D.L. in Cambridge and San Francisco from 1972-74. . . . **William R. Hively** writes: "I am working on a Ph.D. in history at the University of California at Santa Barbara. Stop by some time and enjoy the climate, beaches, and oil slicks."

Ralph G. Brindis is enjoying Emory Medical School, finishing his third year. He will be in Boston this fall for the senior elective in cardiology at Boston Children's Hospital. . . . **Tim Maloney** has finished his Ph.D. at Cornell and is staying on for a postdoctorate in Electrical Engineering, doing some more research and teaching. **Cathy A. Buckley** is working for a transportation planning agency trying to make Boston a better bet for bicyclists. . . . **John G. Chamberlin** formed a data processing consulting firm in September, 1975, which is now Arkansas Systems, Inc., with a staff of six. **Donald L. Estes, Jr.**, writes: "Took eight years but I finally received my S.B. (VIII) in June, 1975. I am presently working as a senior programmer for a local corporation and am seeking a Ph.D. program in clinical psychology (hopefully in New England). Anyone passing through San Antonio stop and say hello."

Lucy and I have moved to Brenham, Tex., and live about nine miles outside of town. We have a great view with a pond on our place from which I caught my breakfast the first morning we were there. We are taking a trip to Europe the last part of August and I will begin practice in September. Keep writing. — **Hal Moorman**, Secretary, P.O. Box 497, Brenham, Tex. 77833

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Well, at last a 1974 class review column appears. Because of the few months I have missed, this will be somewhat long.

Tom Wolff writes: "I am still doing research at Exxon Research and Engineering Company in Linden, N.J., as a Stanford-Exxon Fellow. In July I will finish my one-year stay and drive my motorcycle home to Highland Park, Ill., and then through the Canadian Rockies on my way back to Stanford. There I will begin my second year as a graduate student in inorganic chemistry."

Andrew Elliot and **William Young** are both second lieutenants who received silver wings following graduation from U.S. Air Force pilot training. Andrew trained at Vance Air Force Base in Oklahoma and will remain there for duty as a T-38 Talon instructor pilot. William trained at Williams Air Force Base in Arizona and will fly the RF-4 Phantom in Germany as part of the U.S. Air Forces in Europe. (see pictures)

Seth Racusen received an M.A. in education at Harvard and is now a part-time instructor in M.I.T.'s School of Humanities creative writing course. . . . **Robert Armbruster** is a second-year medical student. . . . **Marty Davidoff** is a first-year law student at Washington University in St. Louis. . . . **Richard Alan Hartman** was married August 6 in St. Louis and is attending the University of Missouri Columbia School of Medicine. . . . **Raymond Van Houtte** is at Cornell graduate school in astronomy. . . . **Jim Gokhale** is now working for Abt Associates, a consulting firm in Cambridge, Mass.

Harvey Michaels is a policy analyst for the Massachusetts Energy Policy Office, doing research in the areas of solar energy and electricity. . . . **Bruce Barton** is an architecture student at Harvard Graduate School of Design. . . . **Paul Schindler** is UPI State House reporter in Hartford, Conn. . . . **Gary Raymond** will be taking the professional engineering certificate test for Illinois in December. . . . **Charles Bruno** is graduating from U.C.L.A. with an M.S. in civil engineering and will begin work in July as an engineer.

Deborah Jackson is in the Physics Department at Stanford University and is visiting the East Coast during the month of September. . . . **Nikolaos Peppas** is now Assistant Professor at Purdue University School of Chemical Engineering, doing research on polymer technology and bioengineering. . . . **Jeffrey Scott Newman** is at Princeton University working towards his Ph.D. . . . **Bill Ladd** received his M.S. in physics from M.I.T. this year and was married in May; he is now attending medical school. . . . **Leonard Harris Davis** is working towards his Ph.D. in synthetic organic chemistry at U.C.L.A. . . . **William Emrich** is working for the solar energy division of General Atomic Company. . . . **Rich Sternberg** has just completed part one of his national medical board examination.

Gerry Rovelsky is "two-thirds completed at J. Reuben Clark Law School — worked during school year on computer applications in the law library. Working my fourth summer parking cars and cleaning dog cages at Disneyland. For this I needed M.I.T. degrees?". . . . **Torben Gronning** will be in Masel, Switzerland for his initial assignment for American Optical in Southbridge, Mass. . . . **C. Demair** has received his M.S. at Sloan School and is now working for Gulf Oil in Pittsburgh. . . . **Philip Doucet** has organized a new company, Computer Controls Company. . . . **Randall Bradley** is currently employed at the architectural and engineering firm of Setter Leach and Linstrom as an architect and is working on a clinic facility project for St. Louis Park, Minn. . . . **Daniel King** has just started a new job with Johnson and Johnson in Chicago. . . . **John R. Cone** is working for Dayco Corporation in North Carolina and "anyone heading for the Smoky Mountains via Asheville is welcome to crash."

John Black is still enjoying life at M.I.T., completing his S.M. in ceramics in Meteorology. . . . **Drew Jaglom** has completed two years of Harvard Law School and is writing for the Harvard *Civil Rights-Civil Liberties Law Review*. . . . **Janice Benson** is in medical school in St. Louis and is active in student government there, helping organize a council and starting a coffeehouse-snack bar. . . . **Johan Norvik** is working towards a Ph.D. in operations research at Berkeley. . . . **Larry Eisenberg** has received a master's in public affairs from the Lyndon Johnson School of Public Affairs in Austin, Texas. . . . Which reminds me, I received my master's in city planning and am now working for the Massachusetts Department of Community Affairs. . . . **Jos Ting** was appointed assistant research officer at the National Research Council of Canada in the Department of Mechanical Engineering, Gas Dynamics Division. . . . **David Doiron** has completed his M.S. in physics at the University of New Hampshire and will start work for a Ph.D. at the University of Iowa.

G.W. Blaney is now working in Venezuela and is going to Berkeley in September to continue graduate work. . . . **S.A. Jordan** is looking forward to graduating from Harvard Business School in 1977 and also expects to see **John Hurd** and **Tim Hult** graduate with him. . . . **Gary Louie** has just started working as a chemist for the Food and Drug Administration in Brooklyn, N.Y. . . . **Peter Grain** is a medical student at Stanford University.

Charles Calhoun has a fellowship for Wharton Business School, where he will be attending this fall for an master's in business administration. . . . **John Hurd** is now married with five step-children. . . . **Bruce Schreiber** is currently working as a systems analyst at the Roosevelt Hospital in Manhattan and is taking graduate courses in computer science at Columbia. . . . **Anthony Luzzi** is working for Digital Equipment Corporation in Massachusetts and will work for them in Canada in 18 months from May. . . . **A. Boghani** is working as a project enjineer at Foster-Miller Associates Inc. in air cushion landing systems. . . . **Arnold Schiemann** is returning to Colombia, South America and will be directing a set of data management systems for the government. . . . **George Arzeno** is attending medical school. . . . **Michael Moreau** has finished his second year at Georgetown Law School and is currently notes editor for the *American Criminal Law Review* at Georgetown University.

David Goldsmith is a supervisor of electrical engineering for two steel companies in Ontario, Canada and will be getting married at the end of the year. . . . **P.G. Haag** is currently working for TMI Systems Corporation designing and implementing money transfer computer systems and got married in May. . . . **Stanley Young** is studying for a Ph.D. in chemistry at the University of Washington in Seattle. . . . **Peter Travis** has completed his first year of medical school at S.U.N.Y. Downstate Medical Center. . . . **Richard Granstein** is still in medical school and studying for the national boards. . . . **Michael Filosa** is working in synthetic organic chemistry at Harvard.

John Daiss is in his second year towards a Ph.D. in biology. . . . **Joseph Whittle** is a geotechnical engineer with Law Engineering Testing Company in Tampa, Fla. . . . **Leon Rivchun** is: "presently making my living as a rock musician playing in bars. Even if the economy crashes, people will still get drunk and I'll be there. Have moved to Vermont and find the people and countryside most enjoyable." . . . **Barbara Keyani** is a research analyst with Interplan Corporation preparing a report on transportation system management plans for the Urban Mass Transportation Administration. . . . **Benjamin Svetitsky** is a graduate student in physics at Princeton University and will be married in winter while at Stanford doing his thesis.

I received a phone call from **Tom Howard**. Tom received a master's in engineering in metallurgy at Carnegie-Mellon University and is going to Indiana to work for Inland Steel Corporation. Tom tells us that **Eric Knorr**, who received his master's in metallurgy from M.I.T. last fall is also working at Inland Steel. Tom also says that **Janet Markham** is working on her doctorate in chemistry at Imperial College of Science and Technology in London, England, and that **Saeqa Dil** is working for the Smithsonian-Harvard Astrophysical Observatory in Cambridge. Saeqa shares an apartment with **Ghiziana Iosif** who is

currently working in Newton designing parts for printing presses. Tom then told me that **Thanet Norabhoompipat** is at Carnegie-Mellon also and will finish his master's in civil engineering in September.

I must regretfully report the death in January of **Michael Mackintosh** who died as a result of a fall while rock climbing in Hawaii, where he was working on his doctorate at the University of Hawaii.

Please note my new address: I moved across the street: **Dennis Dickstein**, Secretary, 17 Forest St., Apt. 34, Cambridge, Mass. 02140

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Well here I go again with piles of news — a very pleasant surprise. To start, we'll go off into the wild blue yonder with some news from our airborn classmates. **Stanley R. Robinson** writes, "I am currently on duty in the U.S.A.F. as a 1st lieutenant. My job is Assistant Professor of Electrical Engineering, in the Department of Electrical Engineering, Air Force Institute of Technology, Wright-Patterson A.F.B., Ohio.". . . **Klaus B. Bartels** tells us that he is stationed at Offutt A.F.B., N.B., as a Communications-Electronics Officer working for S.A.C. Headquarters. He too is a 1st lieutenant. . . . And of course my bewinged and faithful correspondent, **Jeff Schweiger** has written to say that he's with Training Squadron 29 at Naval Air Station, Corpus Christi, Tex., attending navigation school. Hopefully by the time you read this, he will have received his Navy "Wings of Gold." Congratulations, Jeff. See you in the sky! . . . Here's another item from a classmate serving the U.S. of A.; **F. C. Mueller**, come September, will complete a 15-month stint in V.I.S.T.A. in Connecticut, and then will attend the Columbia School of Public Health. Says Mueller, "V.I.S.T.A. is great! Between it and M.I.T., one's mind can get a thorough shake-up." I thought M.I.T. was quite enough.

The nationwide employment scene may be dismal but '75 M.I.T. grads seem to be doing just fine. **Peter M. Kunigk** just moved to New York City to work for Lehman Brothers Investment Bankers. . . . **Michael Kozinetz** is "presently living and working in Baton Rouge as a cost engineer for Badger America, Inc. Louisiana is quite a change from Boston and I'm really enjoying my 'Southern Adventure.' It's quite an experience to work on a construction jobsite after four years of academics! But it's great fun and a good experience." . . . **David S. Kelly** says he's "leaving the womb of academic research starting this month (June, '76). I'll be working as a programmer/designer for Teledyne Controls here in Los Angeles. They develop computer control systems for industrial and scientific applications. (In leisure news — I'm now in a folk dance performing troupe — show biz!)" . . . **David A. Fink** writes: "After a period of unemployment last summer following layoff from Pratt & Whitney Aircraft (I never started work there but was given severance pay) I am presently working as an engineer at Thermo-Electron in Waltham, Mass." . . . And here's a blast (sandblast, if you'll excuse my pun) from **J. Eidinger**. "I am chiselling out a living at the concrete lab at Berkeley. I am planning to stick around here until December 1977, when I will go back to Montreal to pick up the pieces of the Olympic Stadium. I'd like to mention that alumnus Jerry Raphael, '34, has made his mark on the Berkeley faculty." . . . **Lawrence J. Metcalfe** is working as a Research Engineer for Aerojet Nuclear in Idaho Falls, Idaho. . . . **Dan Breen** started working for Conrail May 5, 1976. He's located in Buffalo during his first year *training* (joke, Dan?) period. Choochoo.

H. R. Davis is returning to Billings, Mont., in a position for Northwest Orient Airlines. "I have spent the last year since graduation training, doing the jobs of Ramp Service and Ticket Agent, so as to completely learn the business. Spent last summer in Billings, the winter in Tampa, Fla., and this summer back in Billings. Not a hard life to say the least!" . . . **David A. Notestein** is currently a consultant for the general management consulting firm of Cresap, McCormick and Paget in New York City. . . . **John Lundblad** is at the height of his career in Public Health-Epidemiology, supporting his climbing habit in the mountains and big walls of the Northwest. He's "working with people instead of numbers and loving it." . . . Anyone who's up Canada-way might want to look up **Gene B. Milgram**. He's working as a research officer at the Institute of Urban Studies, University of Winnipeg, Manitoba, Canada, R3B2E9. He'd enjoy hearing from anyone passing through.

Do I hear the pitter patter of little feet? I suppose I do, because news is that **Lila Kobylak Kung** and **Ru-Mei Kung** are married and have a lovely son, Yung-Shin. Ru-Mei is a math graduate student at U.C. Berkeley and Lila is presently staying home with their son. . . . Also, **Abbot L. Moffat II**, a graduate student in Course I's structures division, and his wife, Jeanne, are eagerly awaiting the arrival of their second child at the time of this writing.

Here's some news from our busy business beavers. **Warren B. Lane** will receive the M.B.A. in Corporate Finance in December '76, from Columbia School of Business. . . . **Mark L. Kalow** is attending the Graduate School of Business at the University of Chicago. . . . And newlywed, **Alan Lefkof**, has finished up his first year at the Harvard Business School. His wife, Ann Gordon, is a graduate student in City Planning, also at Harvard. . . . **Ian Fisher** writes, "Since graduating from M.I.T.'s Sloan School, in June '75, I have been working as an Investment Banker with the Canadian Division of Merrill Lynch, Pierce, Fenner and Smith in New York City." He married Tobey R. Avner (Simmons '75) last October. She is an Assistant Research Analyst at Kidder Peabody & Co.'s research department. . . . **Joyce** and Chris, '74, **Demain** have moved to Pennsylvania. Chris, who finished his master's at Sloan in '75, will be working for Gulf in Pittsburgh, Penn. Joyce has quit her job with Raytheon in Massachusetts and will be looking for work in her new residence.

For those of us with our noses still to grindstone in school, here's the latest scoop from the academia alcove. **Diane M. McKnight** took courses this summer at Friday Harbor Marine Station off the coast of Washington. She's back at M.I.T. this fall for her second year of grad school (C.E. Water Resources). . . . **Esref Unsal** is at Penn State in the Chemical Engineering Department going for the Ph.D. His field is tertiary oil recovery via polymer solutions. "Life is not as fast here as it was at L.C.A. in Boston; however, country life is nice. I have turned into a pretty strong Nittany Lion fan." . . . **B. N. Davidson** is finishing up at the University of Southern California in the School of Urban and Regional Planning — working towards a master's in planning. This summer he studied in Guatemala with the Institute for Nutrition in Central America and Panama (I.N.C.A.P.). . . . **Paul R. Giguere** completed a master's program in Water Resources Planning at Stanford. He informs me that other classmates also receiving M.S.'s in water studies there are **Fonda Thompson**, **Carlos Riva**, and **"Woody" Priebjrivat**. Paul has accepted a position with Water Resources Engineer, Inc. in Walnut Creek, Calif., and started there this summer. He has run into **Ernie Brown**, **Roy Greenwald** and **Gail Green** (the latter two will wed in December). He also saw Tom Parkinson, '74, who stopped by on his way back to D.C. from Hawaii. He'll be back at Stanford this fall. **Pat Schultz** is finishing his M.B.A. at Stanford this year.

David B. Leep writes that there is great satisfaction in serving as a T.A. in the Math Department at the University of Michigan. His grad courses are going very well. . . . Have heard the word from **Guy Plunkett** in Madison, Wisc. He's working towards his M.S. and Ph.D. in bacteriology. He's learning to enjoy Madison more and more. "It's a good place . . . no Boston, but then Boston's no Madison either." . . . **Alan B. Sopelak** is enjoying the Berkeley sunshine and in the meantime is working on master's degrees in computer science and management science. He adds: "Some other M.I.T. '75 people here at U.C. Berkeley are **Richard Stratt**, **Gil Sanchez**, **Henry Luftman**, **Dave Lee**, **Bernie** and Terry **Brooks** and **Pete Rubinstein**. Some of us have formed a competitive bowling team in one of the U.C. Berkeley bowling leagues. We call ourselves the 'Brass Rats'!" . . . **Sandy Kelly** is a grad student in Education at Tufts University. She's also teaching high school math in public school and coaching gymnastics. . . . Lawyer-to-be **Loren Dessonville** has completed his first year of law school at the University of Chicago. . . . **Judy Fairchild** is a medical student at U.C.L.A. Judy returned to Boston this summer and worked at the Peter Bent Brigham Hospital doing research with membrane oxygenators. . . . In an Amherst University news round-up, I learned that **Michael Delaney** is a grad student in the Department of Chemistry there. He has been awarded a university fellowship. . . . Congratulations are in order for **Howard W. Davis** who has been awarded the 1976-77 Marron W. Fort Fellowship at M.I.T. Howard completed his first year in the joint Harvard-M.I.T. Health Sciences and Technology Program this past year. . . . **Elliot Feit** received an M.S. in applied mathematics this past June at Harvard.

Several people received graduate degrees in '75. **Joan D. Shaio** is completing her Ph.D. in political science at Johns Hopkins University. During the summer of '76 she worked as a research assistant at the World Bank. . . . **W.A. Weinhold** is enjoying his work on the faculty at the Harvard Business School. . . . Finally, **Robert E. Sacks** is a programmer/analyst for S. & H. Information Systems, Sysks and Hennessy, Engineers, Inc, N.Y.

Two last things. **Jim Moody** was elected to the M.I.T. Corporation as a Representative from recent classes. . . . And finally **Dennis M. Crumpler** poses the question "Who is John Galt?" Well, I'm afraid I'll have to shrug on this one but perhaps Ayn Rand could help.

Thank you for writing, and I hope all is well with everyone else in the Class of '75. — **Jennifer Gordon**, Secretary-Treasurer, 5 Centre St., Apt. 32, Cambridge, Mass. 02139

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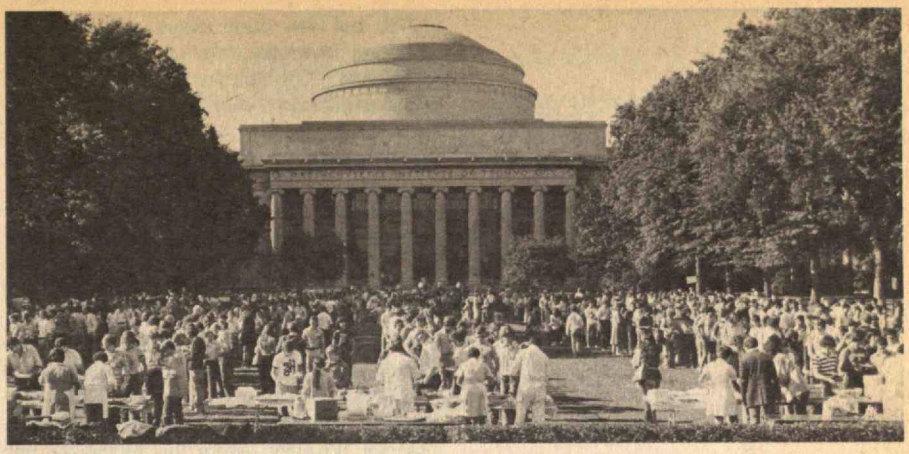
I bumped into **Vincent Richman** a few days ago at the Student Center. He told me about his summer job as manager of Computer Operations for the Boston Poison Information Center, the organization in the front of the phonebook which advises people what to do when their children have ingested something like, to quote Vincent, "the tub and tile cleaner!" He's had a "junket" to D.C., which is very good for a summer job. He's responsible for producing statistics for Greater Boston, with a delay of only a week, versus, he told me, the 20-month delay of the national clearinghouse for poison control!

I saw **Erland Van Lidthe de Jeude** a few hours after he got back from Montreal. He made the Greco-Roman wrestling team as an alternate, so he got to go to Montreal. He would have wrestled if the no. 1 heavyweight fell ill, but just the opposite happened. He got food poisoning, though you'd never guess it, for he looks fine now. However, he did get to see Nadia Comaneci perform, so all wasn't lost.

John Hagmann, **Lindsay Weaver**, **Stephen Yee Yan Young**, and **Larry Hirsch** have all done quite well. John was just commissioned as an officer in the army and has been accepted to the very first class of the Uniformed Medical Services medical school in Bethesda, Md. . . . Lindsay has been awarded a Schlumberger Foundation Fellowship for graduate study at the 'Tute. He's getting $7,000 to cover tuition and living expenses, a very nice award. . . . Steve has been awarded an Eastman-Kodak Fellowship for study next year at M.I.T. He's getting $6,000 to cover next year's bills. It awarded one of four Dean's Merit Fellowships for graduate study in the College of Engineering and Applied Science at U. Penn. The four Fellowship recipients were chosen from 380 students.

That's all for this month. Do write to me. I like getting mail. — **Arthur J. Carp**, Secretary, 67 Badger Cir., Milton, Mass. 02186

Under the Domes



A bright sun welcomed the Class of 1980 at their freshmen picnic.

1,065 Expected in the Class of 1980; "Yield" Falls

A week before they were due to arrive, Peter H. Richardson, '48, Director of Admissions, was forecasting that 1,065 students would present themselves on September 3 as members of M.I.T.'s Class of 1980. That's 35 less than the 1,100 set as a target by the Academic Council last spring — but enough to press hard on housing resources in dormitories and fraternities.

Included in the Class, said Mr. Richardson, would be 175 women — about the same as last year — and 61 blacks; the latter is double the number who came in the Class of 1979, and Mr. Richardson said "we are pleased."

One cause for concern emerged during the summer: the "yield" — the proportion of admitted students who finally chose to come to M.I.T. — dropped six percentage points, from 55 per cent in 1975 to 49 per cent in 1976. William J. Hecht, '61, Director, wrote M.I.T.'s Educational Council members during the summer that "a drop of this magnitude does not appear to have been shared by other first-rate private colleges. We need to understand what happened," he said, "and what steps we can take in the future."

But Mr. Hecht emphasized that the number of applicants for the Class of 1980 had been the largest in M.I.T.'s history, "and we have a first-rate group of young men and women in the Class."

New Fraternity and New Cooperative

Two new housing groups on the campus this fall — the first in many years. An M.I.T. chapter of the national fraternity Alpha Delta Phi had a successful rush — some 25 members. And 20 coeds have joined to form a new Women's Independent Living Group.

Both are living at 351 Massachusetts Avenue, just south of Central Square in Cambridge, an apartment house converted for their use by M.I.T.'s Northgate Corp. The entire building — 351-353-355 Massachusetts Avenue — will be rehabilitated in a project being directed for M.I.T. by James H. Eacker, '55.

As the project proceeds, A.D.P. and W.I.L.G. will move from their unimproved entry into a rehabilitated one, and eventually it's expected that the two groups will grow to occupy the whole building. When that happens, they'll ask the Independent Residence Development Fund for a mortgage loan so that they can become co-owners as well as tenants.

Meanwhile, workers won a photo-finish race to complete rehabilitation work in Bexley Hall before students returned in September. The $300,000 project included complete new kitchens and bathrooms, new paint, new plumbing and wiring, and a new roof.

Pressing on the Press in an Election Year

How does the national press — magazines, newspapers, radio, television, acting as "information brokers" to the American people — affect the way we elect a President?

M.I.T.'s News Study Group is working on an answer to that question throughout the 1976 election campaigns — a "new window through which to view the political process," says Thomas J. Piper, '75, project director.

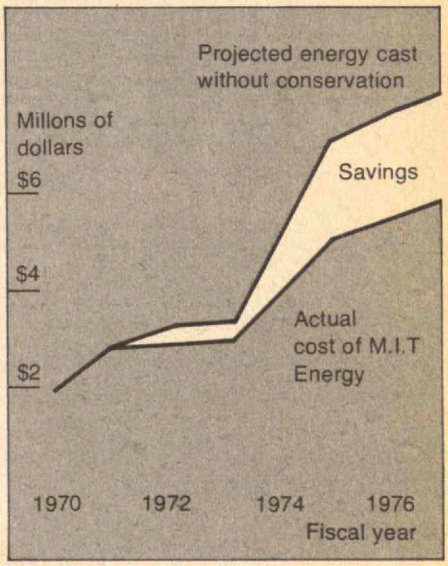
Already students and staff have worked to document interaction between press, candidates, and delegates at the Democratic and Republican National Conventions. Now they're continuing to monitor communications as the campaign develops. The result will be a series of magazine articles, perhaps a book, probably a documentary film assembled from "minicam" footage made at the conventions and video tapes of network news broadcasts. And Mr. Piper hopes to give some film-augmented lectures.

The project grows out of the interests of Edwin Diamond, formerly of *Newsweek*, who is now Senior Lecturer in the Department of Political Science. It's funded from M.I.T. sources and through a $15,000 grant from the Alfred P. Sloan Foundation.

$6.3 Million at 5.989 Per Cent

M.I.T.'s New House, a dormitory for 300 undergraduates adjoining MacGregor House on Memorial Drive, was financed this fall with a $6.3 million bond issue of the Massachusetts Health and Educational Facilities Authority. The net interest rate to M.I.T. was 5.989 per cent.

New House was opened in the fall of



Savings: More than $1 Million a Year

In the six years since energy conservation efforts began, they've saved M.I.T. some $7.5 million, thinks Carl W. Hagge, '57, Environmental Engineer in the M.I.T. Department of Physical Plant. Annual savings are now running well above $2.5 million.

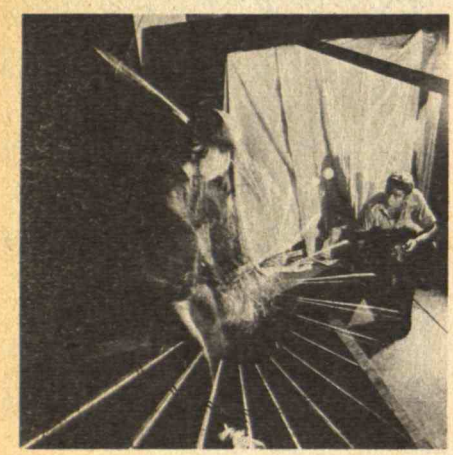
1975, but the bond issue was delayed, awaiting favorable interest rates. John A. Currie, M.I.T.'s Director of Finance, thinks the interest rate a year ago might have been near 8.5 per cent. They're "revenue" bonds, to be repaid out of revenues generated by New House itself.

Batter Up — in the Strobe Lab

Should a baseball bat be made of aluminum, or wood?

Professional baseball favors the wooden bat; aluminum bats, it's thought, would drive the ball farther and change the crucial balance of power between batters and fielders. Sandlot baseball favors the aluminum bat: it's cheaper and lasts longer.

James M. Hagadus, '78 — true to his M.I.T. training — opts for research. Hence his project sponsored by M.I.T.'s Undergraduate Research Opportunities Program (U.R.O.P.): What are the differences — if any — between balls hit by wooden and aluminum baseball bats?



Jim Hagadus, '78, sets his strobe to catch the swinging bat of Rick Miller of the Red Sox. He is designing a batting machine to demonstrate the differences — if any — between balls hit by wooden and aluminum bats.

To obtain controlled conditions for his tests, Mr. Hagadus — his major is mechanical engineering and photography is one of his hobbies — decided he needed a batting machine. It had to hit the ball consistently every time, and it had to duplicate the stance and swing of a baseball batter.

What really happens to the bat when a hitter swings it? Boston Red Sox outfielder Rick Miller came to M.I.T. last spring to answer that question, swinging his bat for stop-action cameras in the M.I.T. Stroboscopic Light Laboratory. From the photographs Mr. Hagadus could trace the course of Rick's bat, and now he's at work on a batting machine which will duplicate Rick's swings. When the batting machine is combined with a pitching machine, Mr. Hagadus will have a way of launching baseballs that consistently duplicates the action over home plate.

The rest will be simple: make multiple-exposure strobe pictures of balls hit by the batting machine equipped with wood and aluminum bats, and from the photographs calculate the velocities of the balls.

Mr. Hagadus believes there will be no demonstrable differences between balls from wooden and aluminum bats, but he says that solid scientific evidence has been lacking. He also wants to compare the speeds of balls hit by new bats and old bats, and in this case, he thinks, the differences may be marked.

The idea of U.R.O.P. is to foster project-based intellectual collaboration between students and faculty in all phases of a research assignment — proposal writing, financing, designing, conduct, analysis, presentation, and rewards.

Rising from the Doldrums at the Sprints

M.I.T.'s varsity crew went to the 74th Intercollegiate Rowing Association Regatta last June at Syracuse the lowest of the underdogs — "about the worst crew at the Sprints," Coach Peter A. Holland told John Powers of the *Boston Globe*. There had been only one victory in the regular season — over winless Columbia.

But it was gloriously different at the Sprints.

On June 3, at the trials, M.I.T. lost to Princeton by only a length — and beat Cornell, Northeastern, and Yale in the process. Two days later the Engineers qualified for the finals by finishing second to Pennsylvania and beating Brown and Northeastern.

That was the climax; the other finalists turned out to be too good for us, and M.I.T. settled for fifth place. But it was the best I.R.A. Regatta showing by M.I.T. in more than a decade — an "incredible high" after a very lackluster season.

Mr. Powers was impressed — "the most cerebral varsity here," he wrote. "Most of them are electrical engineering majors — number 5 Karl Lofgren ('76) has been working on an artificial voice prosthetic, and number 2 Mark Pickrell ('76) is tinkering with a prototype nuclear fusion reactor." Captain Peter Beaman, '76, helped the image: "We had a lot of guys up until three in the morning working on theses at the end of the season," he told Mr. Powers.

M.I.T. in (and Out of) the Olympics

Two M.I.T. athletes, both members of the varsity heavyweight crew (*see above*), were in Montreal as Olympic contestants, M.I.T.'s first Olympic participants in many years. John G. Everett rowed in the number-seven seat of the U.S. eights boat, and Gary G. Piantedosi, '76, filled a seat in the coxless-four shell.

Four other Olympic hopefuls among the undergraduates missed out. Jerome F. Dausman, '76, and Alan F. Marcum, '78, and Stephan C. Goldstein, '76 — he was world intercollegiate pistol champion during the regular season last year — lacked time and funds to attend the Olympic trials; and Erland van Lidth de Jeude, '76, M.I.T.'s 340-pound heavyweight wrestler, was simply outwrestled in the team trials.

Championship Lost, but Does it Matter?

Last May the women's sailing team thought it was in reach of the national championship, being sailed — for the first time ever — on the Charles River. Not quite; though they were New England champions, they had to settle for a finish second to Princeton.

Reporting these events in the mid-summer issue of *The Tech*, Glenn R. Brownstein, '77, Editor-in-Chief, reminded his readers that comparing M.I.T.'s athletic fortunes with those of "Division I powerhouses" is both "unfair and inappropriate." The important thing, he said, is that "the Institute varsity remained the largest in the nation with 29 intercollegiate sports, and [there was] an all-time high level of participation."

Expropriating the China — a "Small Dent"

If you're invited to dinner at an M.I.T. fraternity this fall, don't be surprised — or upset — to be served on M.I.T. Food Service china and eat with M.I.T. Food Service flatware.

S. Edward Leonard, Director of the Food Services, admits that there's a steady, slow drain of utensils from dining halls to private rooms and houses. But the Food Services' order of replacement flatware, china, and glassware — $7,000-worth in 1974-75, he told Thomas M. Mayer, '78, of *The Tech,* is less than 1.3 per cent of his annual budget — "a very small dent," said Mr. Mayer.

But "the sheer numbers are staggering," Mr. Mayer reported — 6,000 dozen teaspoons, 486 dozen pieces of china, $500-worth of glassware in the replacement order to cover losses and breakage of all kinds.

Taking M.I.T. to 14,000 People a Day

It was work and fun in the sun at the same time for four M.I.T. undergraduates this summer — Joan M. O'Brien, '79, Jonah L. Garbus, '79, Daniel T. Jaime, '78, and Mark R. Schwartz, '79: they were the Institute's hosts at N.A.S.A.'s "Third Century America" exhibition at the Kennedy Space Center, Cape Canaveral.

M.I.T.'s exhibits focused on SAS-3, the Small Astronomy Satellite 3 whose experiments were designed and built in the Center for Space Research. But the students' biggest job was to answer questions about M.I.T. itself for some of the 14,000 viewers a day who came by in the three-plus months between Memorial Day and Labor Day.

Can S.E.R.I. Come to M.I.T.?

Where to put the new National Solar Energy Research Institute?

The Energy Research and Development Administration has before it 20 answers to that sweepstakes question put forward by as many local chambers of commerce, universities, and industrial consortia. One of them — "we think it is a winner," says Edward J. King, President of the New England Council — would put S.E.R.I. at 70 Memorial Drive, Cambridge (next to M.I.T.'s Sloan Building), under the direction of Lawrence Levy, S. M. '48.

Mr. Levy headed the proposal team for the New England Council, and the proposal itself was a regional effort supported by all six states. Arthur B. Slater of Raytheon Co. was Deputy Director of the proposal team, and Claude W. Brenner, '47 was assistant Director.

S.E.R.I. may have a first-year budget of $4 to $6 million. Under the New England Council proposal it would start business in the M.I.T.-owned building formerly occupied by National Research Corp.; within five years it would move to a permanent site where more space was available — perhaps the Simplex property northwest of M.I.T. in Cambridge or a state-owned tract in Westboro.

A decision on S.E.R.I's location and management is expected from E. R. D. A. in December.

The Greens Add $3 Million for Professorships

Cecil H. Green, '23, and his wife Ida have given M.I.T. major support for the Institute's tallest building housing the Departments of Earth and Planetary Sciences and Meteorology, $1 million for graduate fellowships, and funds to support three distinguished endowed professorships.

Now this summer has come an additional $3 million — "an important step forward in M.I.T.'s $225-million Leadership Campaign," said Howard W. Johnson, Chairman of the Corporation — for three endowed professorships, two in the earth sciences and one in the Department of Physics.

Mr. Johnson noted that 50 endowed professorships are listed among the goals of the Leadership Campaign, and he said "M.I.T. continues to be grateful to the Greens for their understanding of the special needs of M.I.T. and their willingness and generosity in helping to meet them."

Mr. Green, who holds S.B. and S.M. degrees in electrical engineering, was co-founder of Geophysical Services, Inc., of Dallas, the predecessor company of Texas Instruments, Inc., a major international electronics firm which he now serves as Honorary Director. Mrs. Green, long a champion of women's education, has shared her husband's interest in M.I.T. and has made independent contributions to the work of the American Association of University Women.

The Skinner Professorship from a "Loyal Son"

Funds providing for the David W. Skinner ('23) Professorship have come to the Institute from a trust created by the late Mr. Skinner, who was chief manufacturing officer as Vice President and later General Manager of Polaroid Corp. from 1946 until his retirement in 1972. He died in 1974.

Before 1946 Mr. Skinner had been in managerial positions with General Electric Co. and (after 1942) was General Factory manager for SKF Industries, Philadelphia. His interest in the Institute was constant; he was adviser and friend to four M.I.T. Presidents, held some 20 different positions for the Alumni Association, was an active member of his Class, and served on the Corporation Development Committee. Indeed, "David Skinner spent the last 30 years of his life working diligently to advance education and research at M.I.T.," says President Jerome B. Wiesner . . . "a loyal son whose qualities of mind and spirit endeared him to thousands who knew him. Now his example of leadership and alumni service will benefit generations of M.I.T. students to come."

This four-sided handshake is to congratulate Associate Professor Woodie C. Flowers (center, right), Ph.D. '73, on appointment to the Class of 1922 Career Development Professorship. With him are (left to right) Alfred A. H. Keil, Dean of the School of Engineering; Walter A. Rosenblith, Provost; and Herbert H. Richardson, '53, Head of the Department of Mechanical Engineering in which Professor Flowers teaches innovative design courses.

Class of 1922 Career Professorship: New Tenant and New Security

Riddle: What grows faster than inflation? Answer: The Class of 1922 Growth Fund.

Five years after the Class of 1922 established its first professorship at M.I.T. — that was back in 1959 — it went on to protect its professorship from erosion by inflation with the Class of 1922 Growth Fund.

Five years more, and the Class was ready for a third project — the Class of 1922 Career Development Fund, designed to help young, untenured faculty members develop teaching skills and professional activities. That Career Development Chair now has its third tenant — Woodie C. Flowers, Ph.D. '73, Associate Professor of Mechanical Engineering — "a truly outstanding young engineer and educator," says Alfred A. H. Keil, Dean of the School of Engineering.

And the Career Development Fund has now been made a beneficiary of the Growth Fund as well, so that its capital is maintained despite threats of inflation. The change will also mean that the Growth Fund can be used to create additional professorships, either senior or career development chairs, according to Parke D. Appel, President of the Class of 1922.

As an instructor in mechanical engineering, Professor Flowers received the Goodwin Medal for outstanding undergraduate teaching in 1971, after he was instrumental in organizing a popular subject in engineering design built around competitions for student designs based on minimal kits of materials. His research is now devoted to technology for improving the mobility of the handicapped, and he has a major role in the design of a new Biomechanics Laboratory being planned in the Department of Mechanical Engineering.

After a year of leading a seminar on land use planning for graduate students in the Joint Center for Urban Studies of M.I.T. and Harvard, Francis W. Sargent, '39, former Governor of Massachusetts, finds the academic pace less frenetic — but no less combative — than the pace of political life. He found himself acting as a referee — trying to find a middle ground among a score of municipal, state, and private land-use officials who appeared in the seminar series. That role turned out to be unfamiliar to his colleagues on the faculty. (Photo: Roger N. Goldstein, '74)

Francis Sargent Brings Political Reality to Urban Studies

Francis W. Sargent, '39, thinks the hard realities of political and public life belong in an urban studies classroom just as much as theory and analysis. That was the idea behind his year-long seminar — just ended — in the Joint Center for Urban Studies of M.I.T. and Harvard.

"I wasn't leading these discussions because I'm a great scholar," Mr. Sargent — he was Governor of Massachusetts from 1970 to 1974 — told *Harvard Gazette* late this spring. It was because "I've been in these positions and have had to make some pretty tough decisions. I think that experience can be useful to academics."

For example, State Senator Alan McKinnon and Representatives John Ames and Robert Wetmore came to talk about land-use legislation. And James Sullivan, City Manager of Cambridge, and Ken Shaw of the Massachusetts League of Cities and Towns talked about home rule and how it works in land planning. Afterwards, Mr. Sargent and his students pondered what they saw as the crucial question: "How do you harness local opinion so that it is not used to stop virtually everything?"

The answer is hard work and compromise, Mr. Sargent told them. "You've got to get local participation. . . . I don't think compromise is a dirty word. In politics you can't follow an extreme point of view."

What's it like to be a teacher, after so many years of public life? Mr. Sargent finds academia's pace less frenetic than that of public service, but curiously combative. "After one semester, two professors came up to me and asked why I tried to bring people together at the end," Mr. Sargent recalled for the *Harvard Gazette*. " 'That really isn't what a seminar is all about,' they said. I suddenly realized — so did they — that maybe that's what I always did. Because, where I was, you had to bring the extremes together and say, 'O.K., this is what we're going to do.' "

Lewis Crampton, who assists Mr. Sargent and who was Massachusetts Commissioner of Community Affairs in the Sargent administration, says seminar participation was "incredible. Graduate students are really hungry for involvement."

Individuals Noteworthy

M.I.T. Administration Changes

J. Peter Bartl, '67, is back at M.I.T. as Industrial Liaison Officer after three years with AMP, Inc., in test and process control equipment, especially automotive diagnostics. . . . **Arthur B. Evans,** formerly with Macmillan, Inc., W. H. Freeman and Co., and Ginn and Co., is Acquisition Editor for Mathematics and Science at the M.I.T. Press. . . . Professor **Robert G. Gallager,** Sc.D. '60, is Associate Director of the Electronic Systems Laboratory with primary responsibility in the area of communications system research. . . . **Dean A. Horn,** Nav. E. '49, is Director of M.I.T.'s $1.5-million Sea Grant Program. As a naval officer he was Professor of Naval Construction from 1968 to 1970 and since then has been associated with administration of Sea Grant work. . . . **Richard W. Keefe,** formerly Director of Alumni Relations at Stonehill College, is Assistant Director of the M.I.T. Development Office.

Promotions to Associate Professor

Thirty-eight Assistant Professors have been promoted to the rank of Associate Professor effective July 1; they are listed below, with their principal fields of teaching and research in parenthesis: **Michael C. Archer,** Department of Nutrition and Food Science (chemical carcinogenesis, applied enzymology, and bioanalytical chemistry) . . . **Klaus-Jurgen Bathe,** Department of Mechanical Engineering (structural mechanics) . . . **B. Shawn Buckley,** Department of Mechanical Engineering (thermic diode solar panels and automatic inspection of machine parts) . . . **Min Chen,** Department of Physics (experimental high-energy physics) . . . **Wayne A. Cornelius,** Department of Political Science (urban politics, Latin American politics, and the politics of development) . . .

John S. Dickey, Jr., Department of Earth and Planetary Sciences (petrology and regional tectonics) . . . **Joseph Ferreira, Jr.,** '67, Department of Urban Studies and Planning (operations research: risk management in insurance and urban services) . . . **James M. Flink,** '64, Department of Nutrition and Food Science (protein resources and freeze-drying technology) . . . **Christopher Goetze,** Department of Earth and Planetary Sciences (mechanical properties and deformation of rocks) . . . **Ann M. Graybiel,** Ph.D. '71, Department of Psychology (brain science; the relationship between brain function and behavior) . . . **Gary A. Hack,** Ph.D. '76, Department of Urban Studies and Planning (urban and city design) . . .

Jerry A. Hausman, Department of Economics (econometrics, energy economics, and microeconomics) . . . **Carl E. Hewitt,** '67, Department of Electrical Engineering and Computer Science (semantics and artificial intelligence) . . . **Douglas A. Hibbs, Jr.,** Department of Political Science (social conflict in advanced industrial societies and modelling strategies) . . . **Ronald A. Hites,** Ph.D. '68, Department of Chemical Engineering (organic environmental chemistry and organic geochemistry) . . . **Berthold K. P. Horn,** Ph.D. '70, Department of Electrical Engineering and Computer Science (computer vision and advanced automation) . . . **Norberto L. M. Kerzman,** Department of Mathematics (Fourier analysis) . . .

Judith T. Kildow, Department of Ocean Engineering (ocean resources and coastal zone management) . . . **Eugene M. Kleinberg,** '67, Department of Mathematics (mathematical logic) . . . **Donald R. Lessard,** Sloan School of Management (financial markets and investment strategies for underdeveloped countries) . . . **Peter Lorange,** Sloan School of Management (long-range corporate planning systems) . . . **Loy D. Lytle,** Department of Nutrition and Food Science (neurochemical and neuroanatomical effects of nutrition) . . . **Stuart E. Madnick,** '66, Sloan School of Management (management information systems and software engineering) . . .

Henry S. Marcus, '67, Department of Ocean Engineering (commodity transportation and economic development) . . . **James W-K Mark,** Department of Mathematics (theoretical astrophysics and applied mathematics) . . . **Roy E. Marsten,** Sloan School of Management (dynamic programming and applications to network design, scheduling, routing, and budgeting) . . . **François M. M. Morel,** Department of Civil Engineering (hydrodynamic and ecological studies of chemical pollutants) . . . **Michael H. O'Hare,** Department of Urban Studies and Planning (environmental policy related to urban design) . . .

Vaughan R. Pratt, Department of Electrical Engineering and Computer Science (computational linguistics and complexity) . . . **Ronald G. Prinn,** Sc.D. '71, Department of Meteorology (composition and dynamics of planetary atmospheres) . . . **Richard S. Sidell,** '65, Department of Mechanical Engineering (modelling, simulation, and control of dynamic systems) . . . **Keith D. Stolzenbach,** Sc.D. '71, Department of Civil Engineering (applications of fluid mechanics to environmental engineering and protection) . . . **Marcus A. Thompson,** Department of Humanities (chamber music, viola) . . .

Cutting Off the Rs and Ss

Four honored by election to the National Academy of Engineering were omitted *(June, p. 94)* by an abreviated alphabet ending with the letter P. The editor's apologies to: **Eric Reissner,** Ph.D. '38, Professor of Applied Mechanics and Mathematics at the University of California at San Diego; **James B. Reswick,** '43, Rancho Los Amigos Hospital, Downey, Calif.; **Reinhardt Schuhmann, Jr.,** '38, Purdue University; and **Morgan C. Sze,** '39, Lummus Co., Bloomfield, N.J.

Minor White, 1909-1976

Minor White

Minor White, a premiere American photographer who was Professor of Photography, Emeritus, in the Department of Architecture, died on June 24 at Massachusetts General Hospital following a heart attack. He was 67.

Professor White studied botany at the University of Minesota but by the late 1930s had turned to photography as an art form. He was associated with the San Francisco Art Institute, George Eastman House and the Rochester Institute of Technology before coming to M.I.T. in 1965 to found the Creative Photography Laboratory. In all these affiliations his principal responsibility was that of teacher, and John Szarkowski, Director of the Photography Department of the Museum of Modern Art in New York, says Professor White's influence rested heavily "on his service as teacher, critic, and 'housemother' for a large portion of the community of serious photographers."

Meanwhile, he was founder and long-time Editor of *Aperture*, an occasional journal of creative photography.

John C. Slater, 1900-1976: A Leader in Quantum Physics

J. C. Slater

John Clarke Slater, Institute Professor, Emeritus, who was one of the world's leading atomic and solid-state physicists, died on June 25 of a heart attack at his home on Sanibel Island, Fla. He was 75. Professor Slater was one of a select few physicists who had major roles in the birth and maturation of quantum physics.

Professor Slater studied at the University of Rochester, where his father was Head of the Department of English, and at Harvard (M.A. 1922, Ph.D. 1923). He came to M.I.T. in 1930 to head the Department of Physics, a post which he held for 21 years until his appointment as M.I.T.'s first Institute Professor. Thereafter he took the lead in forming a Solid-State and Molecular Theory Group at M.I.T. in 1952 and later the interdisciplinary Center for Materials Science and Engineering in 1961.

But it is for research contributions that Professor Slater will be especially remembered. William Shockley, Ph.D. '36, co-inventor of the transistor, postulated that device on the basis of his understanding of semiconductors achieved while a doctoral student under Dr. Slater's direction, and Mervin J. Kelley, former President of Bell Telephone Laboratories, credits Professor Slater and "a few other academicians in solid-state physics" with work that made the transistor invention possible.

Professor Slater's work during World War II led to general understanding of microwave oscillator theory and the transmission of microwaves, and after the war he was a prime mover in the plans to transform M.I.T.'s Radiation Laboratory into the Reasearch Laboratory of Electronics and the Laboratory for Nuclear Science.

Following retirement from M. I. T. in 1966, Professor Slater divided his time between the Institute and the University of Florida at Gainesville, where he was (since 1964) Graduate Research Professor of Physics and Chemistry and a leader in that school's Quantum Theory Project.

Constance D. Boyd, 1906-1976

Constance D. Boyd, a member of the M.I.T. community for more than 30 years, died on July 14. She was most recently Senior Editor of the M.I.T. Press, having earlier served the Press as Editor-in-Chief, Executive Editor, and Assistant to the Director. Miss Boyd came to the M.I.T. Radiation Laboratory in 1943 from a post as Research Assistant to the late Harlow Shapley at the Harvard College Observatory.

Carolyn B. Cox, 1917-1976

As Director of the Registry of Guests, Carolyn B. Cox guided thousands of foreign visitors and guests through M.I.T. between 1960 and 1976; she died following a long illness on July 15. Mrs. Cox came to M.I.T. as secretary to the Dean of the Graduate School in 1946; she later served as secretary to Julius A. Stratton, '26, when he was Provost, Chancellor, and finally President of the Institute.

Joshua B. Feldman, 1918-1976

Before his retirement in 1975, Joshua B. "Bernie" Feldman, '40, had been Executive Officer (1955-1973) and Head of the Administration and Facilities Department of the Charles S. Draper Laboratory; he died on July 2 at the age of 58. Mr. Feldman returned to M.I.T. after World War II Navy service to work on gunsights and fire control equipment, and as the Instrumentation Laboratory became the Draper Laboratory and then was separated from the Institute he continued with ever-growing administrative responsibilities.

Alfred E. Ennis, 1919-1976

Alfred E. Ennis, well known to students as Manager of Kresge Auditorium and the Student Center before he joined the central administration of M.I.T.'s Physical Plant Department in 1972, died after a brief illness on August 1. He was 57. Mr. Ennis started his M.I.T. career in 1946 as a painter, and he became its Assistant Manager when Kresge Auditorium opened in 1957.

Arthur E. Mitsch, 1896-1976

Arthur E. Mitsch, Chief Accountant for ten years before his retirement in 1961 and then Special Assistant to the Comptroller and Consultant to the Fiscal Planning and Budget Office, died on June 14 at age 80. Mr. Mitsch came to M.I.T. in 1942, and he quickly developed a wide circle of friends through his varied accounting responsibilities. An avid golfer, he was adviser to the varsity golf team for many years and served as freshman coach from 1968 to 1971.

Abner Stodder, 1893-1976

Abner Stodder was one of six 50-year M.I.T. employees; a retired electrician in the Department of Physical Plant, he died on August 2 at the age of 83. His first day working for M.I.T. was in 1911, in the Rogers Building in the Back Bay; among other assignments, he was responsible for electrical wiring at all 50 Commencements during his period of active service at the Institute. One year, when it came time to change the Institute's many clocks to Daylight Saving Time, he did the job in short order — on roller skates.

Deceased

Arthur B. White, '00; November 30, 1975; 4380 Glenwood Dr., Riverside, Calif.
Edward H. Davis, '01; June 5, 1976; 40 Gaylord Dr., Waterbury, Conn.
George H. Garcelon, '03; March 19, 1976; 55 Cooper St., Agawam, Mass.
Everett R. Cowen, '07; May 18, 1976; 2702 Cameron Ct., Louisville, Ky.
Ferdinand J. Friedman, '08; May 11, 1976; 3555 Cote De Neiges Rd., Montreal, Quebec
Arthur T. Hinckley, '08; August 11, 1975; P.O. Box 65, Youngstown, N.Y.
George D. Whittle, '08; January 25, 1976; 1276 Dana Ave., Palo Alto, Calif.
John G. Ahlers, '10; May 2, 1976; 1532 Dunn St., Moses Lake, Wash.
Roy Gay Mac Pherson, '11; February 17, 1976; 80 Warren Rd., Framingham, Mass.
Gordon B. Wilkes, '11; February 16, 1976; P.O. Box 726, E. Orleans, Mass.
Frank W. Caldwell, '12; December 24, 1974; 54 Pilgrim Rd., West Hartford, Conn.
Herbert B. Alvord, '13; March 27, 1976; 4703 Hunt Ave., Chevy Chase, Md.
Ellis W. Hartford, '13; February 18, 1976; 1956 Belding Dr., Palm Springs, Calif.
Arnold S. Wahl, '13; November 18, 1975; c/o 5317 Lyman, Dawners Grove, Ill.
Ernest Weller, '13; June 4, 1976; Box 734 Market Path, Setauket, N.Y.
Frank L. Surls, '15; May 2, 1976; 506 West Howry Ave., DeLand, Fla.
Mark Lemmon, '16; December 22, 1975; 3211 Mocking Bird Lane, Dallas, Tex.
Donald P. Daniels, '17; January 22, 1975; c/o Connie M. Lopez, Box 3609 Terminal Annex, Los Angeles, Calif.
Leland C. Roberts, '17; May 13, 1976; 507 Ellis Hollow Creek Rd., R.D.2, Ithaca, N.Y.
Stuart M. Boyd, '18; March 26, 1976; 25555 PGA Blvd., Palm Beach Gardens, Fla.
Ralph C. Flewelling, '19; December 30, 1975; 499 Bellefontaine, Pasadena, Calif.
Alfred G. Hoffman, '19; January 3, 1976; Box 90, Waco, Ill.
Frank L. Bradley, '20; May 21, 1976; 11 Pineridge Rd., Reading, Mass.
Isaac B. Simon, '20; December 13, 1974; Apt. 621, 6101 16th St. N.W., Washington, D.C.
Howard J. Williams, '20; July 2, 1976; 20 Colby Rd, Braintree, Mass.
George A. Chutter, '21; July 19, 1976; 17 Boulder Dr., E. Dennis, Mass.
Elmer W. Davis, '21; November, 1975; 1600 East Ave. Apt. 1106; Rochester, N.Y.
Roy C. Mitchell, '21; April 17, 1976; 210 West University Dr., Chapel Hill, N.C.
Lester F. Rhodes, '21; August 20, 1975; 969 Santa Cruz Way, Rohnert Park, Calif.
Holland L. Robb, '21; October 18, 1975; 10646 Saratoga Cir., Sun City, Ariz.
Myer A. Weisman, '21; January, 1976; 701 So. St. Andrews Pl., Los Angeles, Calif.
Otis C. Angier, '22; June 5, 1976; 2623 Seville Blvd.#204., Clearwater, Fla.
Boyd M. Begg, '22; June 17, 1976; 1590 Orchard Ln., Walnut Creek, Calif.
Lawrence R. Culver, '22; November 23, 1975; 205 N. AIA #203, Satellite Beach, Fla.
Benjamin A. Dickson, '22; February 14, 1976; 518 Mill Brook Rd., Devon, Fla.
Dale D. Spoor, '22; May 16, 1976; 710 Spottswood Rd., Richmond, Va.
Sydney W. Blackett, '23; June 3, 1976; 1196 S. Duncan Ave., Clearwater, Fla.
Robert Colburn, '23; May 21, 1975; 15 Brook St., Wellesley, Mass.
J. Raymond Eiffe, Jr., June 6, 1976; 60 Bauer Terr., Elizabeth, N.J.
Hyman F. Marshall, '23; June, 1976; 12 Highfield Rd., Quincy, Mass.
Allard M. Valentine, '23; January 23, 1976; 396 Glen Rd., Weston, Mass.
Elwood A. Windham, '23; April 24, 1976; 299 Bayberry Dr., c/o St. Onge, Stamford, Conn.
Vernon C. Ambler, '24; March 15, 1975; Box 1177, Rockport, Tex.
Alexander J. Bone, '24; March 30, 1976; 66 Commonwealth Ave., Chestnut Hill, Mass.
James L. Guion, '24; January 27, 1976, 35 Riverview Terr., Springfield, Mass.
Robert E. Huthsteiner, '25; March 11, 1976; P.O. Box 2008, El Paso, Tex.

Harold D. Werner, '25; October 10, 1975; 3320 Argyle Ave., Erie, Penn.
Alton S. Heyser, '26; 18 West Maryland Ave., Rockville, Md.
Richard Plummer, '26; May 16, 1976, c/o 140 Federal St., Boston, Mass.
Arthur C. Sutton, '26; January 27, 1976; 281 Magellan Ave., San Francisco, Calif.
Albert H. Burton, '27; September 18, 1975; 3717 N. Fruit, Fresno, Calif.
Francis J. Connolly, '27; July 2, 1976; P.O. Box 616, Avalon, Calif.
Charles W. Frank, '27; March 30, 1976; 1106 North Washington St., Wheaton, Ill.
Philip M. Clark, '28; March 18, 1976; 180 Clyde St., Brookline, Mass.
Henry D. Harrington, '28; November, 1975; 219 S. Cleveland Ave., Lancaster Village, Wilmington, Del.
Edwin S. Kant, '28; June 25, 1976; 68 Laurel St., Melrose, Mass.
William H. Woods, '28; February 8, 1976; 5011 Imogene St., Houston, Tex.
Will W. White, '29; February 14, 1976; 200 Newbury Ter., San Antonio, Tex.
Ana Davidson, '30; January 22, 1974; Box 259, Haverford, Penn.
Royce G. Kloeffler, '30; July 29, 1975; 1235 S. Highland Ave., Kalmia Apt. #102-D, Clearwater, Fla.
Ormond M. Lissak, '30; March 14, 1976; 10795 Loyola Dr., Los Altos, Calif.
Thomas W. Mackesey, '32; May 2, 1976; 301 Dewitt Pk. Apts., Ithaca, N.Y.
Thomas J. McNaughton, '32; December 30, 1975; 3009 Clermont Ave., Pittsburgh, Penn.
Morgan S. Campbell, '34; June 2, 1976; 2835 Dominique, Galveston, Tex.
John A. Maxim, '33; December, 1975; 34 Hopkins St., Wakefield, Mass.
John H. Ellison, '34; May 3, 1976; 1720 Holly Ave., Menlo Park, Calif.
Robert J. Frazier, '34; March 19, 1976; 8 Centennial Ave., Gloucester, Mass.
Fred J. Bensin, '35; February 1, 1976; 62 Old Country Rd., Melville, N.Y.
Howard E. Bernhardt, '35; February 1, 1976; 26 Valley View Ter., Moorestown, N.J.
Vern E. Dress, '37; March 31, 1976; 8901 Eton Space 110, Canoga Park, Calif.
Marcellus W. Dyer, '37; March 31, 1976; 9 Riverview Ave., Ardsley, N.Y.
Henry J. Sieradzki, '38; March 23, 1975; 48 Wildwood Dr., Dix Hills, N.Y.
Joshua B. Feldman, '40; July 2, 1976; 40 Silver Birch Rd., Waban, Mass.
Richard G. Sawler, '41; June 8, 1976; 17 Granite St., Melrose, Mass.
Mary E. Elder, '43; May 30, 1976; 22 Chauncy St., Cambridge, Mass.
James N. Hendell, '46; June 4, 1976; c/o R.F.D. # B ox 116, Plymouth, N.H.
Bruce S. Dodd, '47; June 22, 1976; 221 So. Main St., Andover, Mass.
Frederick A. Woods, '47; November 30, 1975; 1224 Ellen Dr., Charleston, W.Va.
Wallace E. Hyde, Jr., '49; June 5, 1976; 1044 Sanders Dr., Moraga, Calif.
William K. Widger, Jr., '49; May 4, 1976; R.F.D. #2, Hillrose Ln., Meredith, N.H.
Raymond S. Ghosn, '50; February 17, 1976; Union Nat'l Bldg., Sanayeh, Beirut, Lebanon.
Donald F. Kenton, '50; December 28, 1971; 69 Oak St., Newport, Vt.
George J. Marlowe, '50; June 8, 1976.
William M. Frank, '51; January, 1976; 11503 Rockbridge Rd., Silver Spring, Md.
Stanley N. Silverman, '53; December 21, 1975; 16 Maniton Way, Scotch Plains, N.J.
Nicholas Philip, '54; April 11, 1975; 507 E 84 St., New York, N.Y.
Steven J. Rau, '55; October 17, 1974; 1945 Placentia Ave., Bldg. A, Costa Mesa, Calif.
Thomas H. Ford, '56; May 11, 1976; 11 Harnden Rd., Pinehurst, Mass.
John G. Waggoner, '58; August, 1975; 1 Mackenzie Dr., Ft. Leonard Wood, Mo.
Alberto Ghitis, '65; June, 1976; Calle 39N N4 150, Cali, Colombia

I
Civil Engineering

What's a research biologist from the Institute of Marine Resources at the University of California (San Diego) doing in the Department of Civil Engineering? Answer: helping members of the Water Resources Division understand the biological effects of engineering interventions in rivers and oceans.

She is **Sallie W. Chisholm,** who joins the Department this fall as Assistant Professor of Civil Engineering; she's been at San Diego since receiving her Ph.D. in 1974 from the State University of New York at Albany. Dr. Chisholm's undergraduate degree is from Skidmore College (1969).

Civil Engineering with the Alumni

Robert C. K. Au, '55, is now Manager of the Atlanta office of Dames and Moore, engineering and environmental consultants. First in Honolulu and later in San Francisco and Atlanta, he has worked on studies for nuclear power plants, dams, transmission lines, offshore structures, buildings, and land projects; he's been a partner in the firm since 1972. . . . **Llewellyn S. Bolton III,** S.M. '60, has been in structural engineering with Zaldastani Associates, Inc., Boston, since 1962, working on — among others — the new Logan Airport Control Tower and Massachusetts General Hospital's Cancer Management Center; Mr. Bolton is now Vice President of the firm. . . . Brigadier General **E. R. ("Vald") Heiberg III,** S.M. '58, is Division Engineer, Ohio River Division, U.S. Army Corps of Engineers. . . . **Charles W. Johnson,** B.E. '55, is Vice President and General Manager of Honeywell's Test Instruments Division, Denver; he's a 19-year Honeywell employee, having started his career in the Aerospace and Defense group in 1956.

One of the San Francisco Bay area's most active M.I.T. men has a new job: **Denman K. McNear,** '48, formerly Vice President-Operations, is now President of the Southern Pacific Transportation Co.; he's been with Southern Pacific ever since graduating. **Ralph R. Rumer, Jr.,** Sc.D. '62 — his degree was in the field of hydrodynamics and water resources — has moved from the State University of New York at Buffalo to become Chairman of the Department of Civil Engineering at the University of Delaware.

Promotions

Francois M. M. Morel (chemical pollutants and trace materials) and **Keith D. Stolzenbach,** '66, (fluid mechanics applied to environmental problems) have been promoted from Assistant to Associate Professor.

II
Mechanical Engineering

Michael P. Cleary, who served as Lecturer in Mechanical Engineering last spring, has now been named Assistant Professor. He's a native of Ireland with a bachelor's degree in engineering from the National University (1972), and before coming to M.I.T. early this year he earned master's and doctorate degrees at Brown.

With the Alumni

When he graduated from M.I.T., **Donald C. Berkey,** S.M. '43, went straight to General Electric Co., where he's been ever since; he's now Vice President and General Manager of G.E.'s Energy Systems and Technology Division, Fairfield, Conn. . . . **John C. Chato,** Ph.D. '60, is Chairman of the Executive Committee of the Bioengineering Faculty, University of Illinois at Urbana-Champaign, where he is Professor of Mechanical Engineering and of Bioengineering; he was made Fellow of A.S.M.E. a year ago.

Since leaving M.I.T., **Franci Fassio,** S. M. '68, has worked for Royal Dutch/Shell in Holland and for Shell Italiana in Italy until 1975; now he's with Snamprogetti, the engineering company of the Italian state oil group — worldwide organization in petrochemical, chemical, and pipeline installations, he says. . . . **Wesley E. Gwatkin,** '38, is Vice President — Operations in the Government Products Division, Pratt and Whitney Aircraft Group, West Palm Beach, Fla.

Until this summer **Charles A. Hathaway,** '43, was President of Torin Corp., Torrington, Conn. Now he's Vice President and General Manager of Bristol Brass Corp's Accurate Forging Corp. . . . **Edward K. Levy,** Sc.D. '67, has been promoted to full Professor in mechanical engineering at Lehigh University, where he's been a member of the faculty since leaving M.I.T. . . . **John H. Midney,** '47 — his LL.B. is from Yale in 1959 — is Assistant Secretary of Emhart Corp. and General Attorney for Emhart Industries, Inc., a wholly owned subsidiary, in New Britain, Conn.

Promotions

Klaus-Jurgen Bathe (structural mechanics and dynamics), **B. Shawn Buckley** (solar energy utilization, automatic machine parts inspection), and **Richard S. Sidell,** '65, (computer modeling, simulation, and control of dynamic systems) have been promoted from Assistant to Associate Professor.

III
Material Science and Engineering

Richard J. Charles, Sc.D. '54, Manager of the Ceramics Branch at the General Electric Research and Development Center, Schenectady, is now teaching in the Department as Adjunct Professor of Ceramic Engineering; it's a new subject

New Head for the Department of Chemical Engineering

K. A. Smith

After moving the Department of Chemical Engineering into its new $14.6-million Ralph Landau Building, Raymond F. Baddour, Sc.D. '51, has stepped down as its Head. He'll return to teaching and research as Lammot du Pont Professor of Chemical Engineering; and he'll be succeeded by Kenneth A. Smith, '58, who was named Acting Head of the Department during the summer by Alfred A. H. Keil, Dean of the School of Engineering.

Professor Smith is an energetic, broad-gauged chemical engineer — a member of the M.I.T. faculty since July, 1961, even before he finished his Sc.D. degree in the Department (1962); he became full professor in 1971.

Professor Smith is Associate Director of the M.I.T. Arteriosclerosis Center; his research and teaching have spanned heat transfer, mass transfer, fluid mechanics, thermodynamics, biomedical engineering, and desalination; he has lectured often at other universities and has extensive acquaintances in industry through consulting on chemical products and industrial processes; in 15 years on the faculty he has more than 60 publications to his credit and has been supervisor or co-supervisor of 30 Ph.D. theses; he is a member of the Editorial Board of the *Journal* of the American Institute of Chemical Engineers, was Chairman of A.I.Ch.E.'s 80th annual meeting in Boston last year, and is Deputy Chairman of Dean Keil's Committee on Engineering Education.

A highlight of Professor Baddour's seven-year tenure as Head of the Department has been the formation of several "transdepartmental" programs in enzyme technology, catalysis, and ion exchange.

in "Applications of Ceramic Processing" in which Professor **Robert L. Coble,** Sc.D. '55, Professor Charles, and others concentrate on the ultimate constraints of microstructure and other microproperties in fabricating ceramic materials.

Professor Charles taught at M.I.T. as a regular member of the faculty in 1954, 1955, and 1956, and he was Visiting Professor last year. His G.E. work has been on the fracture, stress, corrosion, and conduction properties of ionic materials.

With the Alumni

By day, **David J. Bromer,** Sc.D. '66, works in research and development for Gillette Co., Boston; by night he turns his hat around and goes to work as a member of the Watertown (Mass.) Housing Authority, to which he was appointed for a five-year term last June. Dr. Bromer tried twice — in 1973 and 1974 — to win elective seats on the W.H.A., and Mrs. Bromer (the *Watertown Press* describes her as a "housing activist") similarly lost in 1970 and 1971; now Dr. Bromer is a state appointee to the job. He will give a "clear majority" to the "reform element" on W.H.A., says the *Watertown Press.*

Gordon R. Lohman, '55, has been promoted to President of the Macwhyte Co., Kenosha, Wis., the wire rope division of Amsted Industries; he's been with Amsted Industries — its President is Goff Smith, S.M. '53, who was a Sloan Fellow at M.I.T. — since 1958, when he completed three years' service with the Air Force. . . . **Louis T. Kiss,** S.M. '69, is back in Victoria, Australia, where he is with the State Electrical Commission, after three months' work as adviser on the application of scanning electron microscopy to material problems at the Marmara Industrial Research Laboratory, Gebze, Turkey. . . . **Robert C. Ruhl,** Ph.D. '67, is Director of Engineering at Chase Brass and Copper Co., Cleveland, where he's just finished start-up of "the world's most highly automated metal slitting line."

Shri N. Singh, S.M. '66, is the author of "Mechanism of Alumina Build-Up in Tundish Nozzles during Continuous Casting of Aluminum-Killed Steels" in *Metallurgical Transactions* for October, 1974, and since then the paper has brought him two major awards: the 1976 Rossiter W. Raymond Memorial Award of A.I.M.E. and the 1976 John Chipman Award of the Iron and Steel Society (A.I.M.E.).

V
Chemistry

Fenton R. McFeely has come from the University of California (Berkeley) to join the chemistry faculty as Assistant Professor this fall. His degrees are from Berkeley (Ph.D. 1976), and his doctoral research was on x-ray photoemission spectroscopy applied to the study of solids.

Shen Professorship

Tsung-Ying Shen, Executive Director of Synthetic Chemistry Research at Merck Sharp and Dohme Research Laboratories, was at M.I.T. from 1952 to 1956 as postdoctoral research associate in chemistry.

Early this year he was selected to receive the Merck and Company Directors' Scientific Award — a $25,000 honorarium — for "outstanding achievements in medicinal chemistry." He chose M.I.T. to receive the honorarium, and it will be used to bring "distinguished synthetic and medicinal chemists" to the campus as visiting professors.

Dr. Shen went directly from M.I.T. to his first assignment in Merck and Company's research laboratories; he's noted especially for discovery of the anti-inflammatory drug Indomethacin.

With the Alumni

Namik K. Aras, Ph.D. '63, is Dean of the School of Arts and Sciences at Middle East Technical University, Ankara, Turkey; his research interests — when he has time for them — are in nuclear and environmental chemistry. . . . **Jeffrey C. Smitley,** S.M. '73, is in the Paper Manufacturing Division, Eastman Kodak Co., Rochester, N.Y. . . . **Rickey M. Turkel,** Ph.D. '68, has completed his M.A. in Slavic Linguistics at Ohio State University, Columbus, where he is Senior Associate Editor in the Organic Chemistry Department of Chemical Abstracts Service.

C. Scott Blackwell, Ph.D. '71, is Project Scientist at Union Carbide Corp.'s Central Scientific Laboratory, Tarrytown (N.Y.) Technical Center. . . . Also with U.C.C.: **Forrest A. Richey, Jr.,** Ph.D. '68, Project Scientist in the Research and Development Department, South Charleston, W. Va.

As a consulting chemist, **Lloyd H. Shaffer,** Ph.D. '49, is giving seminars in solar space heating for the Department of Commerce's National Technical Information Service; he wants to establish himself as a consultant in this field, he says; "it's not profitable at the moment but I'm hopeful about the future."

Promotions

Mark S. Wrighton (photochemistry) and **Christopher T. Walsh** (biochemistry and bio-organic chemistry — a joint appointment with the Department of Biology) have been promoted from Assistant to Associate Professor.

VI
Electrical Engineering

Louis-Francois Pau, Professor at the Ecole Nationale Superieure des Telecommunications, Paris, and Lecturer in the Department of Engineering at Cambridge University, England, was Visiting Scientist in the Department for three months last winter. Now he's back as Visiting Associate Professor, working in R.L.E.'s Cognitive Information Processing Group and teaching a subject in Failure Diagnosis as part the Communication Science Seminar. Professor Pau is a native of Denmark with early training in aerospace engineering in Marseilles and later work in applied mathematics at the University of Paris (Sc.D. 1975).

With the Alumni

Joseph F. Folk, Ph.D. '72, is with the Consolidated Rail Corp. — Conrail — in Philadelphia as Director of Costing and Economic Analysis. . . . **Stephen J. Jatras,** S.M. '52, President of Telex Corp., Tulsa, has been named to the Board of Trustees of Carnegie-Mellon University, from which he received his B.S. in 1947. . . . Volume 2 of **Leonard Kleinrock**'s (Ph.D. '63) *Queueing Systems* (subtitled *Computer Applications)* was published in June by John Wiley and Sons; Dr. Kleinrock — he's Professor of Computer Science at the University of California (Los Angeles) — says computers are the only tool capable of solving the enormous complexity of queueing theory equations, and queueing theory is an ideal medium for computer systems analysis; hence the book.

Vytautas Klemas, '58, Associate Professor of Marine Studies at the University of Delaware, is Director of the University's new Center for Remote Sensing; it will build on a program already developed by Dr. Klemas for monitoring coastal resources by integrating data from satellites, aerial photographs, and field work.

Kurt J. Linden, S.M. '61, has moved from research and development at Raytheon Co. to be Manager of the Solid-State Device Section of Laser Analytics, Inc., Lexington, Mass. . . . **Herbert W. Mower,** Sc.D. '72, continued work at M.I.T.'s High Voltage Engineering Laboratory after receiving his doctorate until this summer; he's now a member of the Scientific Staff of the New England Medical Center Hospital, in the Department of Therapeutic Radiology. . . . **Clark W. Thurston,** E.E. '68, is Manager of Control Technology in the Engineering Department, Union Carbide Chemicals and Plastics Technical Center, Charleston, W. Va.

Daniel U. Wilde has been promoted to Professor of Information Administration, University of Connecticut, Storrs; he holds N.A.S.A.'s 1975 Public Service Award for his work as Director of the New England Research Application Center. . . . **Charles A. Zraket,** S.M. '53, MITRE Corp.'s Senior Vice President for Technical Operations, is Vice Chairman for two years of the Virginia Governor's Council on Transportation.

Wendell P. Monroe, S.M. '18, died March 25, 1976, at the age of 81. He had retired in 1968 following a career which included engineering electrification of the Illinois Central Railroad in Chicago, consulting on the San Francisco-Oakland Bay Bridge, and consulting for the Los Angeles Metropolitan Transit Authority. He was at various times associated with Jackson and Moreland, the Chicago Department of Subways and Highways, Sargen and Lundy, and Mann, Johnson and Mendenhall.

Promotions

Four Assistant Professors have been promoted to the rank of Associate Professor: **Carl E. Hewitt,** '67 (artificial intelligence and procedural semantics), **Berthold K. P. Horn,** Ph.D. '70, (visual perception and artificial intelligence), **Vaughan R. Pratt** (program semantics and computational linguistics), and **Alan S. Willsky,** '69 (automatic control theory).

X
Chemical Engineering

With the Alumni

William W. Clark, '44, previously project manager in research and engineering, is now manager of Process and Chemical Development at Standard Oil Co. (Ohio), Cleveland. . . . Even before he finished his doctorate, **Charles A. Gray,** Ph.D. '66, went to work with FMC Corp.; now he's been promoted to Assistant Director of Process Research and Engineering at FMC's Princeton (N.J.) Research and Development Center. His job will involve handling — among other things — process research development, engineering pilot plant preparation, economic analysis, and research plant liaison for the FMC's Agricultural Chemical Division.

Thomas O. McNearney, Jr., '48, has been named Chairman of the St. Louis Federal Savings and Loan Association, of which he was previously Executive Vice President. . . . **Walter L. Milliken,** S.M. '46, New York area Sales Manager for E.I du Pont de Nemours and Co., is in the midst of a busy year as President of New Canaan (Conn.) United Way, Inc.

All technical areas of the Plastic Products Division of Owens-Illinois, Inc., are now the responsibility of **Paul H. Rothschild,** '58, who's been promoted to Technical Director and Vice President of the Division. . . . **Herbert I. Scher,** '51, is now Chief Laminate Engineer for the Nevamar Division, Exxon Chemical Co. U.S.A., Odenton, Md. . . . A promotion for **John B. Schmidt,** Sc.D. '62: Executive Vice President for marketing, operations, and commercial development of Oxirane International, a joint venture of Halcon International, Inc., and Altantic Richfield Co. . . . **Anthony Stathoplos,** '51, is now Projects Manager — Nuclear Reload Fuel for C-E Power Systems, Windsor, Conn. . . . After five years with Arthur D. Little, Inc., in the U. S. and Brazil, **Sergio C. Trinidade,** Ph.D. '73, has become Executive Director of Centro de Technologia Promon in Rio de Janeiro.

Promotion

Ronald A. Hites, Ph.D. '68, whose work is in the field of environmental organic chemistry and geochemistry, has been promoted from Assistant to Associate Professor.

XIII
Ocean Engineering

Commander **Franklin F. Alvarez,** U.S.N., Sc.D. '66, has joined the Department of Ocean Engineering as Associate Professor; he'll teach in the field of naval ship design. Professor Alvarez has served aboard the *U.S.S. Los Angeles,* the *U.S.S. Cogswell,* and the *U.S.S. Midway;* he was stationed at the Hunters Point Naval Shipyard for three years ending in 1971 and most recently has been Assistant for Engineering Systems in the Navy's Major Surface Combat Ships Project.

With the Alumni

Captain **W. J. Broughton,** N.E. '61, of the Canadian Navy is Director of Maritime Engineering and Maintenance in the Canadian National Defense Headquarters, Ottawa. . . . Lieutenant Commander **John G. Champlain** (U.S.N.), S.M. '71, has recently transferred from the Long Beach Naval Shipyard to the Ship Maintenance and Modernization Division, Office of the Chief of Naval Operations, Washington.

Donald P. Courtsal, S.M. '56, joined the Engineering Works Division of Dravo Corp. in 1965 and was named General Manager of the Division in 1975; now he's also Vice President of Dravo Corp. . . . **Ira G. Cruckshank,** '43, is Vice President — Research and Product Engineering for Stanley Tools.

After a decade with the U.S. Atomic Energy Commision, **Edwin E. Kintner,** S.M. '46, is now Director of the Division of Controlled Thermonuclear Research in the Energy Research and Development Administration; he's had wide experience in naval and power reactors with the U.S. Navy and A.E.C.

Sales of contruction services to the electric utility industry are the new responsibility of **John H. Randall,** S.M. '48, as Product Manager — Construction Services for C-E Power Systems, Windsor, Conn. . . . The most advanced ship simulator of its kind in the world — the Maritime Administration's Computer-Aided Operations Research Facility at Kings Point, N.Y. — was dedicated last May; **Virgil W. Rinehart,** N.E. '54, has been its Program Manager for the Maritime Administration since 1972.

Alexander J. Tachmindji, S.M. '51, formerly Deputy Director of the Department of Defense Advanced Research Projects Agency, is Vice President — Washington Operations of MITRE Corp., McLean, Va. . . . Commander **Peter T. Tarpgaard** (U.S.N.), Ph.D. '70, is working with the U.S. Arms Control and Disarmament Agency on issues related to the S.A.L.T. talks.

Promotions

Judith T. Kildow (ocean resources and their management) and **Henry S. Marcus,** S.M. '67, (transportation policy and management) who has been Chairman of the Graduate Program in Shipping and Shipbuilding Management, have been promoted from Assistant to Associate Professors.

XV
Management

The former Director of Massachusetts' Office of Economic Analysis (Executive Office of Economic Affairs) has come to the Sloan School this fall as Assistant Professor of Industrial Relations. He's **Thomas A. Barocci,** who was a Lecturer in the School last year when he was also Director of Boston University's Regional Manpower Institute. His research is in the fields of employment policy, labor, and economic development.

Benjamin C. Ball, Jr., '48, Vice President — Planning Research at Gulf Oil Corp., is now Visiting Senior Lecturer at M.I.T. He'll be working at the Sloan School on the M.I.T. Energy Laboratory's energy management and economics program, a study of research and development pol-

P. H. Rothschild

H. I. Scher

J. P. Schmidt

I. G. Cruckshank

J. H. Randall

A. J. Tachmindji

Management for Cities

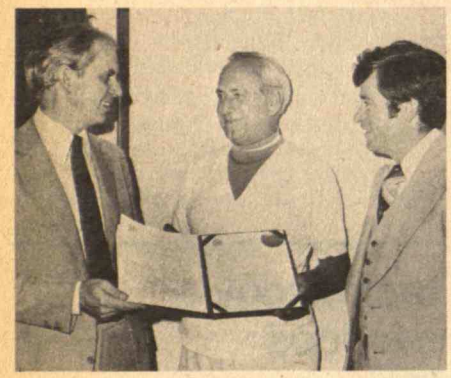
How did Gerald W. Henigsman, Assistant to the City Manager of Dallas, cut the $1.6-million deficit of the Dallas Convention Center to $750,000?

By applying techniques of planning and control he learned in the Sloan School's Program for Urban Executives, he told *Business Week* this summer. For one thing, by improving personnel productivity by staffing for normal requirements rather than for peak business. He admitted the approach "sounds simple," but it was new to Dallas.

Mr. Henigsman was the 12th executive to come from Dallas for one of the nine sessions of the Urban Executives Program held to date. Another prominent repeater is Seattle — nine in as many sessions.

The point of the Program, says Alan F. White, S.M. '71, its Director (he was a Sloan Fellow in 1970-71), is that cities have to deal with "broadly oriented social and economic problems," and people who run cities need educational opportunities "comparable to those offered business executives."

Four themes are covered in the four-week session: how to formulate policy, how organizations and people in them behave, the environment for uban decision-making, and management science. In presenting these topics, the Sloan School has advice and counsel of the National League of Cities, the U.S. Conference of Mayors, the International City Management Association, and the American Society for Public Administration. Over 200 people in all fields of urban affairs — health, safety, public welfare and services, management, libraries, planning, parks, utilities, development, and finance have attended.



It was Urban Executives Month in Cambridge last July — a special salute from the city to the Sloan School's Urban Executives Program. It all happened when Robert W. Healy *(right)*, Assistant City Manager for Administration in Cambridge, finished his classes in the ninth session of the Program. Mayor Alfred E. Vellucci *(center)* prepared a proclamation to the effect that "the cities are the heartbeat of a nation . . . their health and vigor depend upon a constant upgrading and renewal of management skills. The City of Cambridge is proud to be home of this unique program . . ." William F. Pounds *(left)*, Dean of the Sloan School, was obviously pleased. *(Photo: Calvin Campbell)*

icy, commercialization, technology assessment, and the future structure of the energy industries. Mr. Ball holds S.B. and S.M. degrees from M.I.T. in chemical engineering.

Shapiro Comes "Home" to M.I.T.

Eli Shapiro, who was a popular teacher in the field of finance at the Sloan School from 1952 to 1961, is back again — this time as Alfred P. Sloan Professor of Management.

During the interim 15 years, Professor Shapiro has taught at the Harvard Business School and — since 1971 — has been Chairman of the Finance Committee and Vice Chairman of the Board of the Travelers Insurance Companies. He returns to take up the Sloan Professorship held by Mason Haire since 1970; Professor Haire retires in June.

Professor Shapiro will retain his posts with the Travelers Board of Directors and Finance Committee, but he will give up responsibilities as President and Director of several Travelers subsidiaries. Professor Shapiro was Professor of Finance at the University of Chicago before coming to M.I.T. in 1952; he studied at Brooklyn College (B.A. 1936) and Columbia University (A.M. 1937, Ph.D. 1939).

With the Alumni

J. Scott Armstrong, Ph.D. '68, is back on the job as Associate Professor of Marketing in the Wharton School (University of Pennsylvania) after a one-and-a-half-year visit at the Stockholm School of Economics. . . . **John C. Avallon,** '48, formerly Senior Vice President for the Precision Materials Group of General Telephone and Electronics Corp., Danvers, Mass., has been promoted to President. . . . In 26 years with Wyatt, Inc., New Haven, Conn., **Philip D. Blanchard,** '24, has devised important new oil terminal operating methods widely copied in the industry; now he's become the company's Senior Vice President. . . . A busy year ahead for **Arthur Gerstenfeld,** Ph.D. '67, who has moved from Boston University to be Head of the Department of Management Engineering at Worcester Polytechnic Institute. . . . Commander **C. Curtis Holcomb** (U.S.N.), S.M. '75, is now Commanding Officer of the Poseidon nuclear submarine *U.S.S. Lafayette.*

Since returning to the University of Southern California from a sabbatical year as Visiting Research Professor at National Taiwan University, **Chi-Yuan Lin,** Ph.D. '68, has become Director of the Doctoral Program at U.S.C.'s Graduate School of Business Administration. . . . **Leonard M. Lodish,** Ph.D. '68, has been promoted to full Professor in the Marketing Department, Wharton School (University of Pennsylvania).

Donald R. Miller, '50, has joined the management consulting/engineering firm of Lester B. Knight and Associates, Inc., Chicago; as Senior Vice President, he will be in charge of the firm's New York office. . . . Superwinch, Putnam, Conn., manufactures electrical winches and hoists, and **William M. Ryan,** S.M. '64, formerly President of Carolyn Chemical Co., Columbus, Ohio, is now Vice President — Marketing. . . . **Richard R. Wood,** '48, President-Elect of the Real Estate Security and Syndication Institue of the National Association of Realtors, is now Vice President and General Manager of the Commercial/Industrial Investment Division, Baird and Warner, Inc., Chicago.

News of Sloan Fellows

Thomas J. Christman, S.M. '59, is Manager — Product Assurance in the Applied Technology Division of TRW, Inc., Redondo Beach, Calif. . . . **Merrill L. Doxtader** has been promoted to Program Manager — Operations at the Kodak Apparatus Division, Rochester, N.Y. . . . Following his year as a Sloan Fellow, **Arland MacKinney,** S.M. '67, became Manager of Babcock and Wilcox's Mt. Vernon, Ind., Works; now he's been promoted to Manager of the Quality Assurance Department in the Company's Nuclear Power Generation Division. . . . **Thomas J. Vincent,** S.M. '68, is President and Chief Executive Officer of Pacific Concrete and Rock Co., Ltd., Honolulu.

Senior Executives

Keith J. Martin (Fall '68) is Managing Director, Shell Marine (U.K.), Ltd., and Director of Shell International Marine, Ltd., London.

Promotions

Five members of the Sloan School faculty have been promoted from Assistant to Associate Professor, effective this fall: **Donald R. Lessard** (financial problems of developing countries), **Peter Lorange** (long-range corporate planning systems), **Stuart E. Madnick,** '66, (computer-based information systems and software engineering), **Roy E. Marsten** (applications of mathematical programming to management), and **John Van Maanen** (criminal justice management).

XVI
Aeronautics and Astronautics

With the Alumni

He's still at TRW, but **Alan P. Daurio,** S.M. '71, has transferred from the Guidance Software Development Department, working on Minuteman, to the Fluid Physics Department, Applied Technology Division; his new work is on chemical laser development and ionosphere studies. . . . **Vivekananda Mukhopadhyay,** Sc.D. '72, is Assistant Professor in the Department of Aeronautical Engineering, Indian Institute of Technology, Kharagpur; he was formerly Senior Engineer in the Indian Space Research Organization. . . . **John E. Prussing,** Sc.D. '67, has been a member of the aeronautical and astronautical engineering faculty at the University of Illinois at Urbana-Champaign since 1969, where his teaching and research are in the area of space mechanics; this year, in addition, he holds a half-time revolving Assistant Deanship in the U.I. College of Engineering. . . . **George A. Reed,** S.M. '47, is Vice President and General Manager of the Product Identification Corp., division of Bristol Brass Co., Hartford, Conn. . . . Major General **Charles L. Wilson** (U.S.A.F.), S.M. '63, is assigned to S.H.A.P.E. (Supreme Headquarters Allied Powers Europe), in charge of a $50-million program for a new protected command center for S.H.A.P.E.

XVII
Political Science

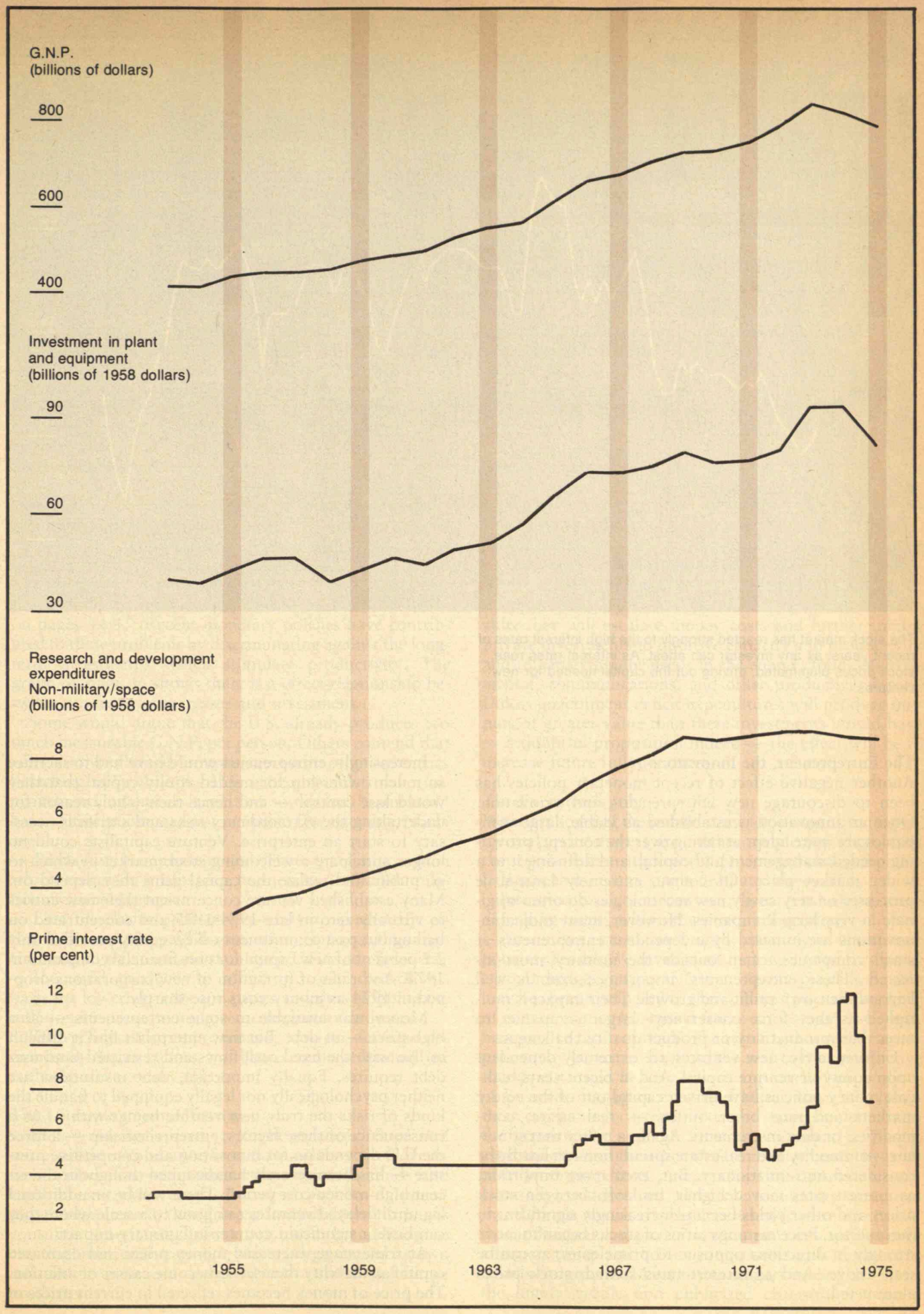
With the Alumni

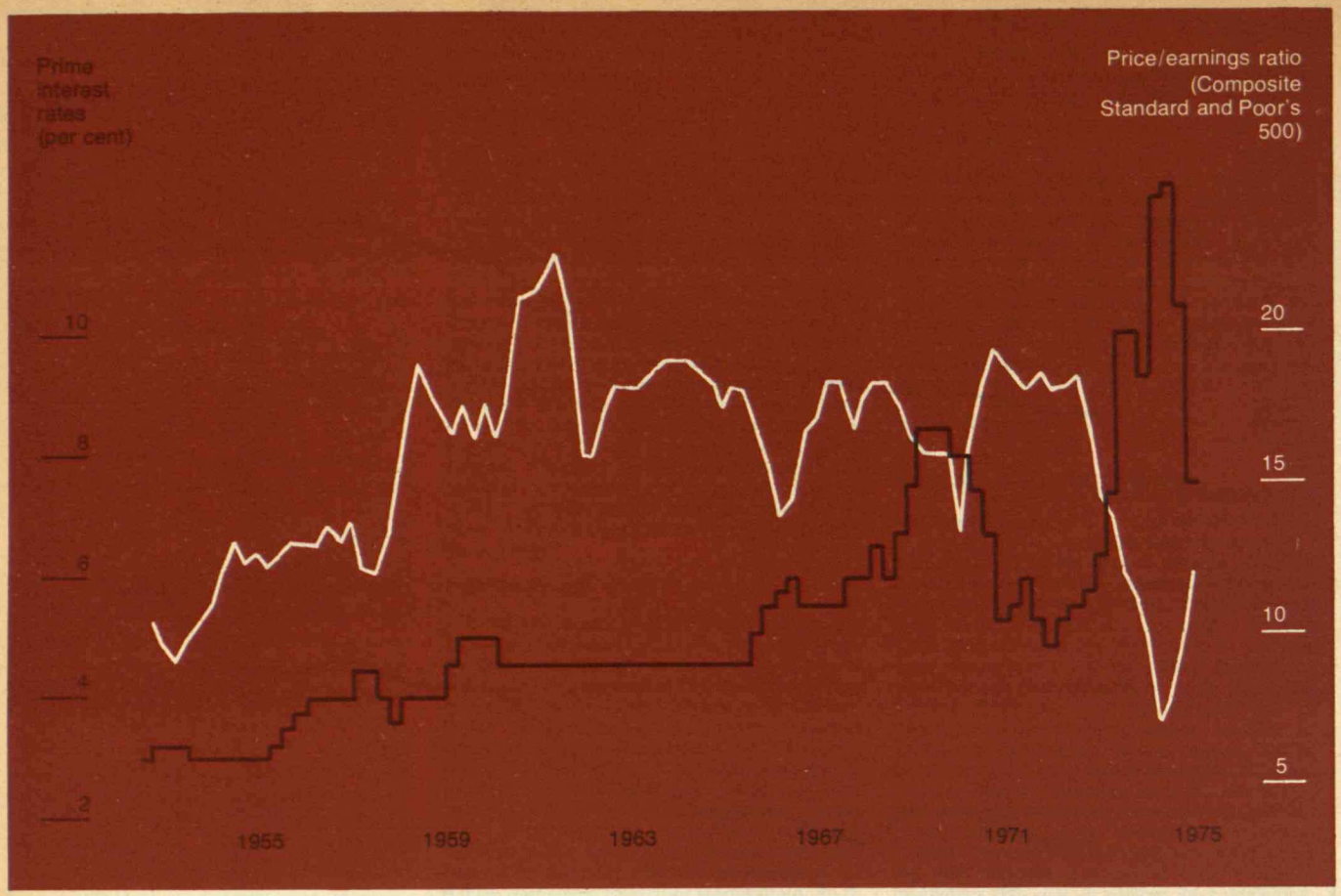
Lewis Austin, Ph.D. '70, is the author of *Japan — the Paradox of Progress;* he "leaves Yale and heads west for a new life," he writes in a cryptic note. . . . Having retired from the U.S. Air Force in the grade of Colonel, **Leo Brachtenbach,** S.M. '65, is studying for his Ph.D. (political science) at the University of Iowa.

"America's basic policy should be not to sell weapons as a matter of policy at all," writes **Anne Hessing Cahn,** Ph.D. '71, in *Harvard* magazine for June. But the arms trade is in fact one of the world's fastest-growing activities, from $2.4 billion to $20 billion in the decade beginning in 1961, and "the U.S. has aptly been called the General Motors of this industry." (Dr. Cahn is Research Fellow at Harvard's Program for Science and International Affairs.)

Promotions

Wayne A. Cornelius (rural-urban development problems in Third-World countries) and **Douglas A. Hibbs, Jr.** (social conflict in industrial societies) have been promoted from Assistant to Associate Professor.


G.N.P.
(billions of dollars)
800
600
400
Investment in plant
and equipment
(billions of 1958 dollars)
90
60
30
Research and development
expenditures
Non-military/space
(billions of 1958 dollars)
8
6
4
Prime interest rate
(per cent)
12
10
8
6
4
2
1955
1959
1963
1967
1971
1975



The stock market has reacted strongly to the high interest rates of recent years, as any investor can attest. As interest rates rose, stock prices plummeted, driving out the capital needed for new ventures.

The Entrepreneur, the Innovator

Another negative effect of recent monetary policies has been to discourage new entrepreneurs and innovation. Once an innovation is established as viable, large companies are quite adept at taking over the concept, providing needed management and capital, and diffusing it to a wider market place. Of course, extremely large-scale processes or very costly new technologies do often originate in very large companies. However, many radical innovations are initiated by independent entrepreneurs or small companies, often outside the industry most affected. These entrepreneurs' importance extends well beyond their own profit and growth. Their impact is multiplied as they force conservative larger companies to meet their productivity or product quality challenges.

Unfortunately, new ventures are extremely dependent upon equity or venture capital. And in recent years high-cost money policies have driven capital out of the equity markets and into other outlets — real estate, commodities, or debt instruments. Again, a policy that stimulates commodity and real estate speculation can hardly be considered anti-inflationary. But, even more important, as interest rates moved higher, tradeoffs between stock prices and other yields became increasingly significant to the investor. Price/earnings ratios of stocks began to move strongly in directions opposite to prime rates, as can be seen above. And as interest rates soared, stock prices plummeted.

Increasingly, entrepreneurs would have had to sacrifice so much ownership for needed equity capital that they would lose control — and hence their whole reason for undertaking the extraordinary risks and sacrifices necessary to start an enterprise. Venture capitalists could no longer anticipate a welcoming stock market in which to go public and realize the capital gains they depend on. Many established venture concerns cut their new entries to virtually zero in late 1974-1975 and concentrated on bailing out past commitments. New equity provided only 2.2 per cent of new capital for non-financial companies in 1974. And rates of formation of new corporations dropped in 1974 as money costs rose sharply.

Money was available to some entrepreneurs — at a high price — as debt. But new enterprises find it difficult to live with the fixed cash flows and restricted fund uses debt requires. Equally important, debt institutions are neither psychologically nor legally equipped to handle the kinds of risks the truly new venture brings with it. As a consequence of these factors, entrepreneurship — a force the U.S. depends on for innovation and competitive pressure — has been severely handicapped thoughout the recent high-money-cost period. There will be an additional lag until delayed ventures can grow to a scale where they can have a significant counter-inflationary impact.

At some stage, increased money prices and decreased capital availability themselves become causes of inflation. The price of money becomes reflected in current prices of

inventoried goods or capital-intensive commodities (like energy) where pricing levels must justify and help recover new investment costs. Owners of plants or buildings constructed with high-cost money must set their prices to recover these costs. Even pricing strategies for new products or processes must try to recoup past and expected money costs. Past money prices thus contribute to current inflation, cause delays in economic recovery, and produce upward price pressures for the future.

In the above sections I have tried to amplify and document some important relationships between recent government financial policies, the U.S. technological structure, and inflationary pressures. The data presented, of course, can only set forth correlations. But observations of actual management responses to money price changes do indicate a strong cause-effect relationship. Both suggest strongly that the low money costs and ready capital availability of the 1950s and early 1960s were among the important *causes* of the highly active, innovative, and low inflationary characteristics of those times. The converse has been true in the late 1960s and mid-1970s. What are the most significant effects of recent policies?

Policy and Productivity

Some of the most significant impacts of the past policies I have outlined are the effects on productivity. However imperfect *G.N.P. per person* or *G.N.P. per person employed* may be as productivity measures, the U.S. still enjoys high ratios compared to other advanced countries. But our *rate* of productivity growth (in G.N.P. per employee) is dropping relative to these countries as is shown on pages 44-45. Recent monetary policies have contributed to these problems by discriminating against the long-term investments which stimulate productivity. The graph on page 46 shows there is a direct relationship between productivity increases and investment.

Some would argue that the U.S. already produces too much measurable G.N.P. per person. Others contend that comparative changes simply represent other countries "catching up" while the U.S. economy must make improvements against a large and somewhat "saturated" base. These points are not at issue. The important facts are:

— Productivity improvements define the limits within which wages or profits can be increased without inflationary consequences;

— Loss of relative productivity tends to increase the effort and resources paid for necessary imports, thus contributing to inflation and damaging U.S. trade balances;

— Increased productivity offers the only controllable basis for lowering costs and prices and thus stopping the inflationary press in any given company or industry.

Real productivity improvements tend to decrease demands for input factors and hence create secondary (or multiple) deflationary effects.

The Unemployment Albatross

Monetary methods used to "fight inflation" have had more subtle secondary effects on productivity. Government policy has maintained stringencies on funds and high interest rates until substantial pockets of unemployment appeared, thus driving demand down further as consumer purchasing power was lost. In addition to creating individual tragedies, this strategy caused its own inflationary push and decreased both current and future productivity.

First of all, the amount of output the unemployed would have contributed was removed from the economy. Yet, the demand they represented was not fully removed. Instead it became politically necessary to supplement incomes of the unemployed through increased unemployment compensation, subsidies, and welfare payments. These attempts to increase incomes without requiring a corresponding productivity output in return were, of course, inflationary in themselves. On the other hand, if the same funds had been spent to employ people in providing needed public facilities or services, similar income benefits would accrue to individuals otherwise unemployed, but the public could reap a positive benefit from their output, as it did from the Civilian Conservation Corps in the 1930s. Incomes, personal dignity, and output could have been maintained. And if benefits received exceeded costs, no inflation (in real terms) needed to result, i.e. the total value of output would have increased more than the cost of inputs. Aggregate productivity might have actually improved. Unfortunately, the income supplementation approach has had the opposite effect.

Another impact of unemployment stems from the fact that the government, for political reasons, quickly begins deficit spending to stimulate the economy, once the economy slows down and unemployment appears. Current estimates of fiscal 1975-1976 deficits aggregate some $117 billion. When added to heavy existing capital demands, such deficits are clearly inflationary in terms of the incremental demands they create. But they also introduce additional inflationary consequences for the future. By preempting capital which would otherwise be available, they will escalate money costs and further inhibit private investments to improve capacity and productivity and to satisfy urgent needs in the energy, food, environmental, communications, and other productive sectors. Unless government deficit expenditures will produce outputs of greater value than these investments would have — a doubtful proposition indeed — the effect will be to increase future inflation rates.

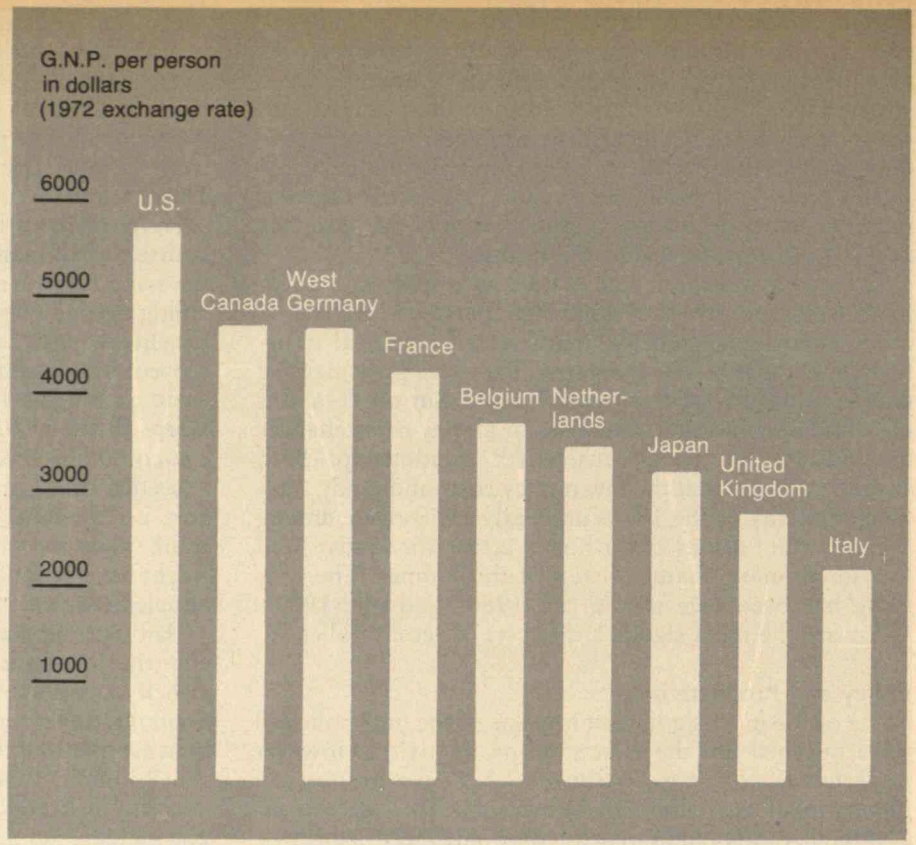
The Executive's Job

What are some of the implications for executives and policy makers? Answers are neither simple nor clear. And they lie more in attitude development and changed policy balances than in any single dramatic policy shift.

Informed executives can do a great deal about these damaging trends within their own companies:

— Executives must start with their own investment policies. Productive investment may well be a very good current hedge against inflation. Assets purchased now may be cheap compared to their inflated prices later. And, of course, money borrowed today can be paid back with inexpensive future dollars. The result is that while money prices may currently be high, the real cost of productive investment could be very low, if approached properly.

— Business managers must find better ways to explain their companies' current needs and future potentials to the government and the financial community. This is especially true of their investment requirements. Because of inflationary effects, many companies' assets are substantially undervalued. Present accounting practices therefore do not clearly disclose what is so often true — that individual companies' investment rates are not even adequate to replace their existing assets much less serve as a basis for growth. Many top managers, feeling driven by the highly visible and publicized criterion of current



The U.S. may still enjoy high productivity (*right*), but our rate of growth in productivity is lagging seriously behind that of other developed nations (*far right*). (Sources: *Right:* M. Boretsky, "Trends in U.S. Technology," *American Scientist,* January-February, 1975; *United Nations Statistical Yearbook, 1973. Far right:* Boretsky, ibid; The Conference Board, "International Productivity and Labor Costs," No. 1771, October, 1975.)

profitability, hesitate to take on the added expenses of major innovation or the risks of investments they can avoid. Sophisticated financial managers can help stimulate a more positive investment climate if their analyses and reports emphasize the implications of inflation accounting and focus less on today's profit potential and more on the long-term. After all, the higher price/earnings ratios, which both managers and investors want, rest on better *future* — not present — return expectations.

— Finally, executives can make sure that internal control systems reflect this longer-term viewpoint. Otherwise short-term performance measures will quickly undercut longer-term commitments. Standards for product quality, innovation, productivity, facilities adequacy, personnel development, employee morale, customer service, supplier and resource adequacy, and future technology development must become routine portions of top management control — with promotional and reward impacts equal to current financial controls. Many diversified companies now proudly emphasize their centralized financial controls and lack of "operational interference" by corporate levels. Without adequate controls over these qualitative variables such companies may appear currently profitable, but often are eroding their long-term viability.

Such internal changes by executives can help. But business and institutional leaders must also influence critical areas of government economic policy. What are the important issues? What policy responses seem feasible and appropriate?

Nothing here suggests that monetary approaches to economic stabilization should be completely abandoned. Nor should money prices be abruptly dropped. Monetary interventions clearly have an important role to play in heating, cooling, or stabilizing the economy. It is not their use, but their *overuse* that is objectionable. Similarly, there are important constraints on decreasing money prices drastically. For example, unless foreign investment or exchange policies were appropriately adjusted, U.S. capital could merely flee abroad in search of higher foreign interest rates. Or over-investment could be stimulated with its associated demand expansion and short-term inflationary consequences. And, obviously, interest rates must exceed expected inflation rates by some margin. Money prices, therefore, need to be lowered in coordination with other fiscal and non-fiscal policy changes which genuinely decrease inflationary pressures and expectations. I suggest some major possibilities below.

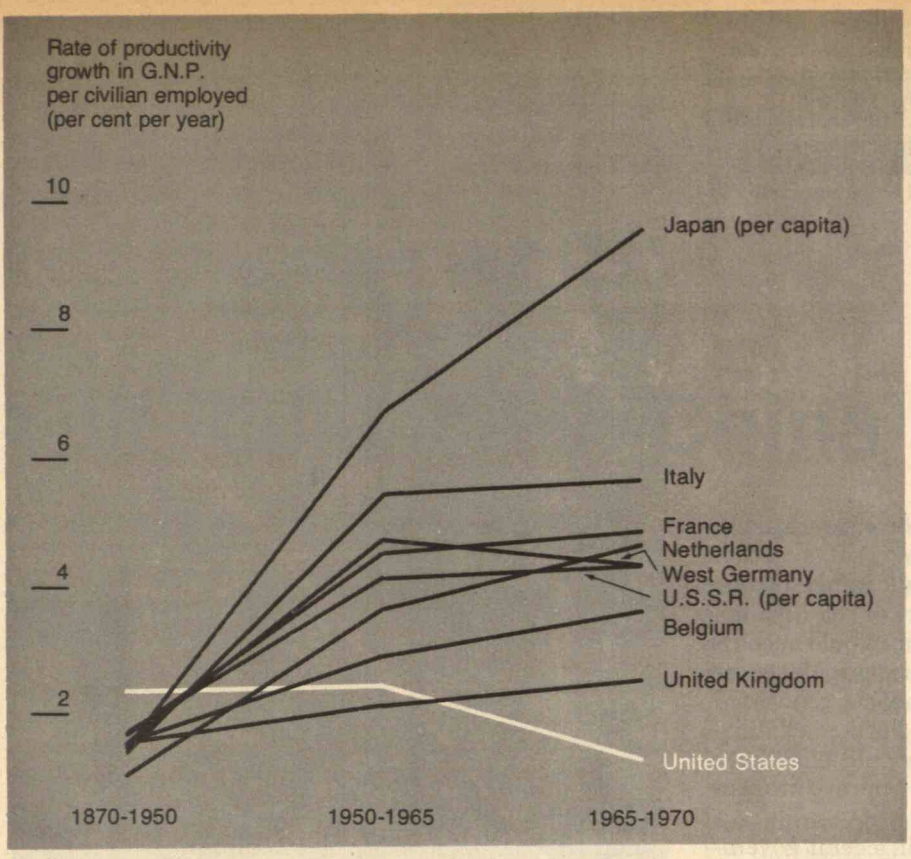
Reestablish Incentives

In recent years many of the government's well intended policy actions have seriously affected the incentives essential to productivity investments, innovation, and risk taking. Instead of positive incentives to save, produce, service, or invest, anomalies like these often appear:

— Savings bank interest rates are pegged at 5 to 5½ per cent while prime loans cost 12 per cent and inflation rates exceed 10 per cent.

— People who work full-time often receive only $16 to $30 per week — or 40¢ to 75¢ per hour more than non-workers living on income supplements because monetary policies induced layoffs in their industries.

— In basic fields like communications, energy, transportation, and electric power, government-controlled prices, based on past investment costs, encourage improper use of resources yet discourage investment and innovation.



— Financial costs force inventory levels so low that supply interruptions, delays, and special expediting costs become commonplace — an odd and costly phenomenon in a recession.

— Major technology and energy companies diversify away from their productivity-increasing specialties and into (less essential) consumer goods where less regulated markets allow higher profits.

One well known example of the effects of these misapplied incentives is the current situation with regard to natural gas. (And this example is by no means unique.)

As most people are aware, U.S. natural gas prices have been pegged at such low levels — due to regulations based on "return-on-original-investment" criteria — that irrational uses of gas were encouraged, while further exploration or development for new U.S. gas sources languished. Then when the energy crisis developed, the oil companies — prime suppliers of natural gas and other fuels — found other incentives removed. Although average yields to oil company investors had been a less-than-spectacular 5.34 per cent from 1964 to 1974, the depletion allowance was withdrawn, price controls were introduced, and "crude sharing" was required. The capacity of these companies to raise capital needed for the next decade's energy development is now in jeopardy. And some companies have attempted to diversify into consumer goods and service activities which look attractive by comparison.

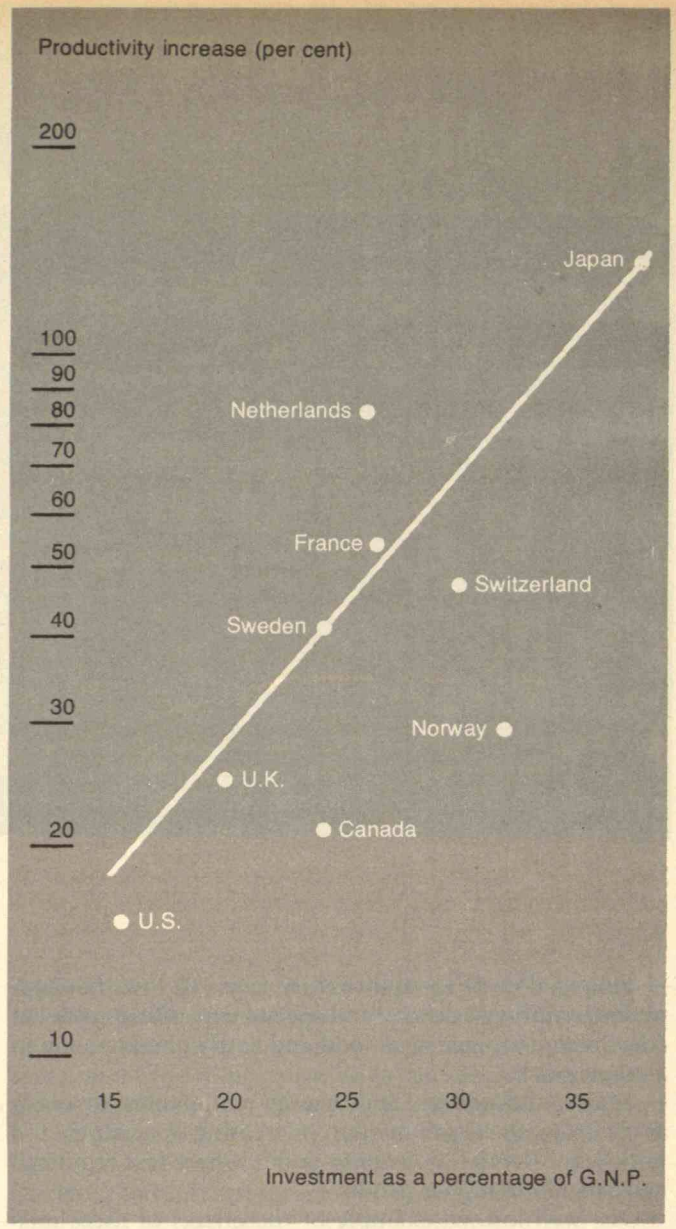
Without attempting the impossible task of specifying a comprehensive set of major policy changes, one can suggest the following general policy adjustments which would alleviate some important problems:

— *Money prices* should be lowered as rapidly as possible without stimulating capital flight overseas or excessive consumer demands. In addition, selective encouragement might be given to capacity expansions, productivity-improving investments, or explorations for new mineral and energy resources. The most acceptable way to lower money prices would probably be to increase tax credits for these specific purposes. Tax credit levels should reflect current and expected money prices.

— *Controlled prices* (in industries like public utilities, communications, and transportation) should allow for adequate investments in research and development, new technologies, and continuous upgrading and replacement of physical plant. Inflation accounting (or replacement cost) bases should be substituted for "original investment cost" bases used in rate setting. Or new formulas should be devised so that rates of return reflect changed money costs and inflationary effects.

— *National welfare policy* should shift from a "guaranteed income" concept toward "full employment guarantees." Removing the last few percentage points of unemployment — perhaps beyond 4 per cent or frictional levels — would clearly be inflationary. But the combined output and motivational effects of using constructive employment to move from existing jobless levels of 4 per cent unemployment should be deflationary as compared to paying almost equivalent incomes to the unemployed, while losing their output. Many advanced European countries have learned to do this, and the U.S. could in time. Lower money prices and effective full employment policies would guarantee that jobs exist and actually increase opportunities for personal fulfillment. Workers and the poor obviously should benefit from and not be forced to pay for productivity gains.

Any policy that discriminates against investment also discriminates against productivity increases. This graph dramatically illustrates the direct relationship between investment and improved productivity. (The line was fitted to the data using a mean absolute deviation fit with a correlation of .917. The least squares method gave a correlation of .693 — the coefficients were significant at the 99 per cent level in the "t" test. Sources: *International Financial Statistics,* International Monetary Fund; and O.E.C.D. Economic Surveys.)



— *Private and corporate savings* could be encouraged in a variety of ways. Further tax relief for personal retirement funds is one example. Increased allowable interest rates for national bank savings accounts or selective tax rates on interest incomes up to fixed limits would encourage personal saving. More realistic depreciation rates or preferential tax rates on corporate income reinvested could stimulate corporate investment. Further elimination of double taxation on dividends would encourage equity investment. And so on. All would improve propensities to invest versus consume.

But such endeavors will be fruitless if federal government expenditures are not related to other savings, investment, and productivity policies. The ratio between federal investment and consumption expenditures must be changed. And the total federal deficit must be explicitly related to state and local deficits as well as national productivity growth.

These government policies require a combination of information, organizational capacities, and statesmanship that has been lacking in the past. But the need is great. And such changes should become more politically feasible as inflationary pressures build.

There are deep contradictions in the use of monetary policy to decrease boom and inflationary pressures over extended periods. Eventually, monetary stringencies become inflationary in themselves. To solve this problem new policies that focus on productivity, innovation, and employment must achieve precedence over those which emphasize demand-cooling, restrained investment, and transfer payments to ease inequities. Such changes may be difficult to implement. But excessive inflation, erosion of national productivity, and unemployment have themselves become issues with political appeal. And they will become national tragedies unless past policy approaches are modified. If we recognize the nature of our past failures, we can begin to explore new options. The real question then becomes whether business and political leadership will emerge to support the broad and balanced changes in economic policy emphasis which are needed. Can U.S. executives and institutions meet this challenge? Or will low productivity and stag-flation become a way of life in the U.S. as they have in Britain and elsewhere?

Suggested Readings

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Patterns and Problems of Technological Innovation in American Industry, Arthur D. Little, "Role and Effect of Technology in the Nation's Economy," Hearings, Senate Committee on Small Business, 88th Congress.

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James Brian Quinn is the William and Josephine Buchanan Professor of Management at the Amos Tuck School of Business Administration, Dartmouth College. He is a consultant on technological planning and has been a frequent contributor to the literature on technology policy and research and development management.

Y. T. Li
Innovation Center
M.I.T.

As we in the United States face resource depletion and technology stagnation, the aura of China becomes especially fascinating

Self-Reliance in China

Four years have now passed since the historic trip of Nixon and Kissinger to the Peoples' Republic of China. Since then, many dignitaries and news correspondents have brought back a picture of a nation with a fantastic growth rate. At first it was China's ability to feed her 800 million people which distinguished her from many other Third World nations, including India. Now it is her fast growing oil industry which fascinates the energy-hungry Western industrial nations.

China's overall policy — one of self-reliance — has been rooted deeply in agriculture while it has, at the same time, been aimed at the development of industry. By rallying behind the farmers, China managed to motivate the masses. Through their concerted effort, the supply-demand balance was tipped to a healthy surplus. Now industry is geared to supply agriculture with labor-saving equipment to gradually shift the huge labor force from agriculture to industry.

All this seems very logical, but it is nevertheless a massive plan. Considering the tightly packed condition of Chinese society, there would seem to be little room left in which to jockey people and programs, let alone create the space required for progress. While China is succeeding, one cannot help but wonder whether the Chinese policy of self-reliance can be adapted by other nations with equal effectiveness. I am reminded of the famous line from the inauguration address of John F. Kennedy: "Ask not what your country can do for you; ask what you can do for your country." As we in the U.S. face resource depletion and technology stagnation, the aura of China becomes especially fascinating.

On the seventh day of July, 1975, my wife Nancy Tung-Tuan, our youngest child Wendy I-Ning, and I arrived in Peking. For me it was a pilgrimage to my birthplace after an absence of 28 years. The brisk walk in warm summer night from the airplane to the terminal building brought back instantly my childhood image of the courtyard in our Peking home. There, on the seventh day of the seventh month, we would gather and gaze at the sky to identify the two stars which, according to legend, represent two deities, the Shepherd of the Ox and the Maid of the Loom. It was on this night of the year that they are supposed to have their once-in-a-year reunion. By some coincidence we were scheduled for a total stay of 28 days, giving us also one day of reunion for every year of my absence.

Presently we got through the terminal checkpoint and were swamped by about two dozen of my relatives and friends. Between identifying some aging but familiar faces and establishing new acquaintances with the younger generation, I found a feeling of pride and love in seeing people who have emerged from the difficult period of the bygone years in excellent health and spirit. Through them, my youthful dreams for a prosperous and independent China seem to have come true. In the ensuing 28 days I got to know these people a good deal more. Equally rewarding was my first-hand observation of the remarkable spirit of self-reliance at work.

Class Stratification Before the Liberation

For thousands of years Chinese history revolved around the organization and schemes of a superstructure which included kings, officials, warlords, landlords, barbarians, bandits, and foreign conquerors. Power changed hands among the ruling classes within this superstructure while the condition of the oppressed masses remained unchanged. The perpetual situation was that the ruling class exacted the maximum amount in levies from the people, leaving the bare minimum for keeping the majority alive. Hunger and sorrow were the way of life, and could have been considered luxuries because, after all, one must at least be alive to perceive these feelings. Most of the classic Chinese folksongs were sad ballads, similar to the blues of the black people in the United States.

In this type of society innovation hardly existed. Although the schemes employed by certain factions at times might have appeared clever and could have been helpful to that particular group in acquiring temporary gain, there was little progress in the society as a whole. For most of the people, innovation was a fruitless activity because under the tenacious hold of the superstructure, every gain over the bare subsistence level would be sucked away as if such were the natural law. In Szechun, for example, where the land was relatively rich by Chinese standards, the warlord jacked up taxes by an ingenious scheme of advancing the tax collection date so that the people were already paying 1975 taxes in 1935.

My first direct contact with Chinese farm people came during World War II in Dading, Kwaichu, a southwest province in China. As an engineer responsible for setting up a new aircraft engine factory, I began my task by building roads and plant sites around a group of natural caves about five miles outside the city wall of Dading. The caves offered protection against Japanese air raids, which had already scored twice at our earlier site outside Kunming. These caves were a lucky find resulting from a chance encounter with a former tutor of mine who, at the time, was in charge of highway engineering nearby. With

his help, I put away temporarily my training in high technology from M.I.T. and the Curtiss Wright Aircraft Engine Co. in the United States to tackle this basic civil engineering job using manpower and ancient facilities. Full of enthusiasm, patriotic feelings, and a Boy Scout spirit, I recruited about 1,000 local peasants and scores of stone masons to help with the task. It was late fall and there was frost in the morning air. Since there was not much activity on the farms it was a good opportunity for the peasants to pick up some extra income. But what a pitiful sight it was when the peasants lined up for the first session — pale and shivering, each of them with only a thin, much patched old rug over their bodies, more for decency than warmth. The wage was set at 1.5 yen per day with considerations for food, tobacco, and miscellaneous expenses. In my youthful zeal, I made it a point to distribute their pay individually at sunset every day despite the chore of making the large number of payroll envelopes.

To my dismay, however, I discovered a week later that a large portion of the workers' windfall still had to be handed over to the straw bosses. Apparently there was someone with real power behind most of these straw bosses. The people simply did not believe that they should keep what they had earned. With the alliance of one straw boss in whose dwelling I had my temporary lodging (in a dusty loft above his pig pen) I convinced a few other bosses to aid me in fighting the rest until the idea took hold that each person was entitled to his earnings. A few months later I received a visitor who identified himself as a special agent from the government in Chungking investigating a complaint involving me. He quickly added, however, that he had been there anonymously for a month and had discovered that the complaint of my alleged wrongdoings was a false accusation. He then showed me a list of my alleged crimes, which included murder and the rape of four local women. (I had served as the master of ceremonies at a wedding of four technicians to four local women.)

As it turned out, the complaint was initiated by a local landlord, Wang the Tiger, who was reputed to have a 50-gun private squad in his yard, and was annoyed by my intrusion into his "territory." After clearing me by his investigation, the agent managed to lure the Tiger to the district federal judge's office through clever maneuvering and had him jailed for making a false accusation. He escaped after a short period and did not bother me again.

Involved in this little episode were several characters — Wang the Tiger, the agent, the judge, and me, the innocent one. For 30 years I had the satisfaction of thinking myself the winner. But now as I review the situation again, I see that it was quite clearly a minor contest within the stratosphere of the ruling class. I also realize now that the paternalistic feelings that I had harbored as a work supervisor existed among the intellectual groups in China even after the liberation. It was only through the traumatic cultural revolution that the great mass of people emerged as the true masters of the nation. They now draft and carry out their own work plans. They need no guidance and handouts from the "intellectuals" and accomplish wonders as never before. This, in fact, constitutes the true motive force of China's self-reliance.

Communization in Agriculture

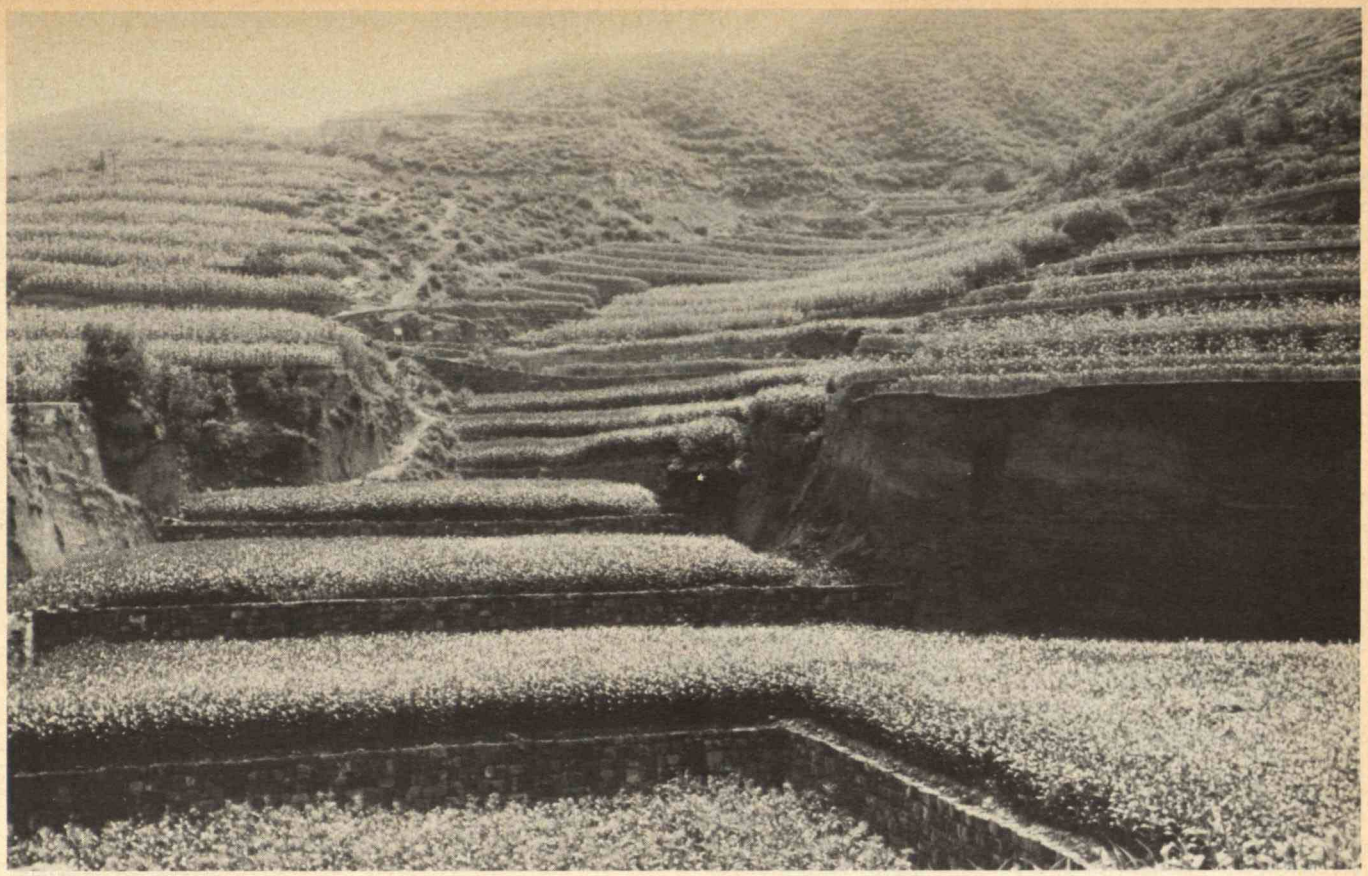
Chairman Mao's policy of giving agriculture first priority differs substantially from policy in the rest of the emerging nations, where priority is usually given to the glamour of industry. As one way to emphasize agriculture in China, the struggle and success of the Dazhai Commune in Shanshi Province was chosen as a national model for the people to follow. This hilly region receives only ten inches of rainfall annually, concentrated in a few summer deluges which cut the terrain into deep gulches that are useless for planting. Yet Dazhai must support an average of five persons per acre — gulches and all. The land in Dazhai is now covered with lush green vegetation, except for one gulch which has been left untouched and named "The Education Gully" to remind the younger generation of the meaning of self-reliance. The remarkable transformation was accomplished by the erection of huge stone retaining walls to hold the earth in terraces. These were then laced with tall aqueducts linking cisterns and reservoirs to distribute and conserve the precious water.

I was particularly impressed when I remembered my own experience in building the same kind of masonry work at the Dading Engine Plant. We had used the same kind of hand tools, though on a much smaller scale. While the people in Dazhai were more motivated and more efficient than we had been, the hard fact remains that it took ten man-years to reclaim one acre of farm land. To appreciate this staggering effort we might note that Dr. Julius Stratton (President Emeritus of M.I.T.) has 500 acres in Vermont which would require 5,000 man-years to be put into shape for production. This would be absurd in the United States, and was also considered impractical by many in China at the time of the Liberation. However, thanks to a few pioneers, the impossible was turned into reality and the outlook on life for the Chinese people has changed completely. Across the land the use of blood and sweat to conquer the natural environment has led to one production record after another, giving the people both material reward and spiritual satisfaction.

But the self-reliance goes beyond physical exertion: the farmers at Dazhai quickly learned how to blend their inherited experiences with modern techniques, including innovation. Dazhai's proud specialty is a "sponge soil" developed to provide a high moisture retention factor matched to their climate and terrain so that their corn, with roots extending two feet deep, can withstand drought for as long as two months.

While squeezing productivity from every inch of the land, the farmers in China also attempt to take advantage of every moment of the growing season. Crops are mixed (for example, an oil seed vegetable is planted after two rice plantings in Hunan) to maximize the total days of land utilization. In this tight schedule, the time needed for harvesting and planting crops was recognized as wasteful. The situation was remedied by recruiting city folk to help with the chores and reclaim some of the valuable growing season. Likewise, medical doctors are organized to serve the peasants on the farm. Thus, in a way, the roles are reversed from the old days when the farmer was destined to serve the city folk.

The economic system and the incentive structure of the commune is unique. A commune is about the size of a small American city; it has between 10,000 and 30,000 inhabitants. Within the commune, individual families own their homes and a small plot of land surrounding the house. The use of this land is at their own disposal, including any profit from selling the produce grown on it. Then there are squadrons — the primary production units, with title to the community-owned land. Squadron



Ten man-years of manual labor was needed to reclaim each acre of farm land at Dazhai. Photo by Wendy Li.

meetings decide the production schedules, review individual contributions to the commune's work, and resolve the final distribution of the harvest's yield to commune members. Larger units called brigades provide all power tools to increase productivity. Finally, the commune as a whole provides all fixed assets such as schools, hospitals, and auxiliary factories. Levies are paid to these higher levels by the squadron for services received. The commune in turn pays taxes to the central government: it pays a percentage of the yield and also sells the government all excess produce after allowing for reserves to be held to guard against famine.

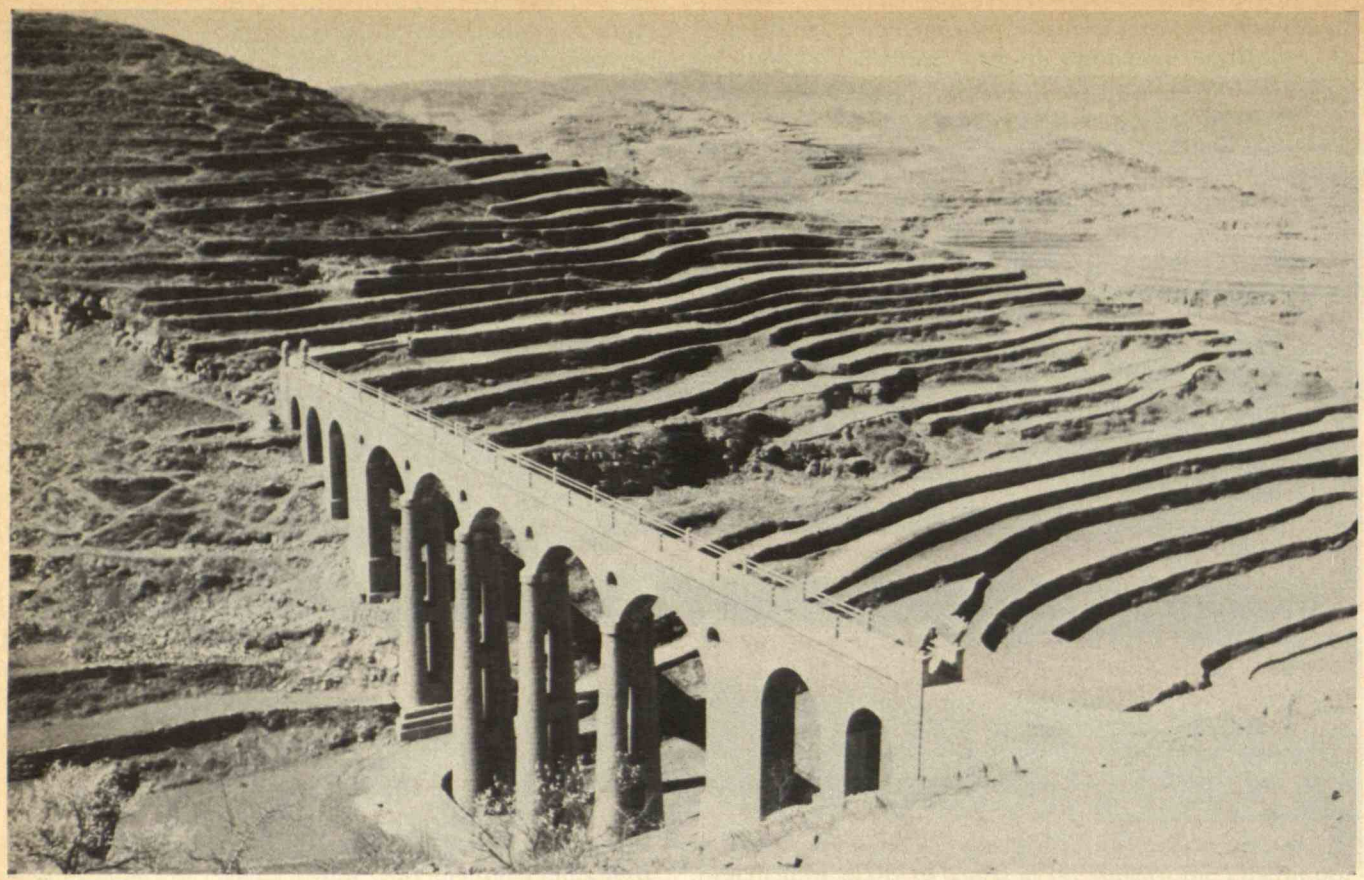
The private ownership of homes and the ability to retain earnings (two differences between the commune and an Israeli kibbutz) give the farmers a sense of freedom. The ownership of such property as equipment and facilities by the brigade and the commune gives the farmers an appreciation of the higher efficiency achieved through group management. This also leads them to appreciate the functions of the various levels of government.

As the efficiency in farming slowly increases, the excess manpower will be absorbed in commune-owned factories. Eventually, however, there will be a major shift of manpower from the farm to government-owned industries. Through that move a worker may come to receive a slightly higher wage, but will relinquish the ownership which is enjoyed by being a member of the commune.

The Exploitation of Oil

Throughout China the national symbol for industrialization is the Dachin Oil Field. This field is located about 200 miles northwest of Halomchiang and was the first major oil field in operation near the Chinese northeast industrial complex. Since the establishment of Dachin, China has developed two other major oil fields, Shen-Li and Da-gong, located in the Shangdon and Hopei provinces respectively. All of these fields were developed by the Chinese without any outside help.

While the oil fields are supposed to set examples of self-reliance to industry, they were and still are the branch of industry with the most government investment. For instance, on the 70-kilometer stretch between Da-gong and Tienstein, the road was almost bumper to bumper with all kinds of vehicles when I was there. In all other Chinese cities, most of the trucks on the road were made in China; this was the only place I saw column after column of huge, Japanese-made trucks. This is evidently one situation where expediency gained the upper hand, and rightly so. Since 1973 China has become for the first time an oil-exporting nation. During the first half of 1975 China produced 55 million tons of crude oil, which was 24 per cent higher than the level of production in 1974 for the same period. Forecasts of China's production in 1980 vary from 200 to 400 million tons, which almost matches the 1974 output of Saudi Arabia.



Over 2,000 miles of oil pipes have been laid over the past two years to bring oil to various cities and shipping terminals. Dozens of refineries and petrochemical plants have been erected around the countryside. One of the largest refinery complexes outside of Peking was situated in front of a steep cliff in the mountains to gain natural protection against surprise attack.

For many years, Western experts, relying upon conventional geological theories, wrote China off as a potential oil producer. And in fact, when the U.S.S.R., prior to 1960, made an extensive effort to help China develop her inland oil fields and do some general prospecting, the results were negative. Had the U.S.S.R. known of China's huge oil reserve, its decision to pull back from the technical collaboration program with the Chinese would probably not have been made.

The years 1962-1963, after the Soviets pulled out, were the most difficult for China. Industrialization was halted. Chinese buses ran on charcoal-burning generators at that time because of the oil shortage. A frantic search for oil began, guided by a new theory proposed by a Chinese geologist, Professor Li Si-Guang. After a study of fossil exploration, he came to believe that since there was ancient biological activity along the Chinese coastal area, there must be oil deposits. He further theorized that the sand dome geological formation is not necessarily the only formation which traps oil. As it turned out, the majority of the oil-bearing beds in eastern China are located at the discontinuity junctions of dissected strata. This made the initial mapping of the field rather difficult until the logic was finally reasoned out.

If the underground geological condition was perplexing in Da-gong, establishing the drilling tower itself appeared quite straightforward. Most of the equipment was made in China. The wells average less than 3,000 meters in depth. The particular drilling squad we visited in Da-gong claimed an average of 50,000 meters drilled per year, and they claimed the record to be 140,000 meters in one year. This amazingly high drilling speed is probably due to the comparative softness of the geological formation, which could also make the present cost of China's oil production rather low.

The head of one producing well was coupled to a set of valves, called an oil-farm-tree (known as a Christmas tree in the United States) and was equipped with other accessories including water-heating jackets and a wax-removing system. From this oil-farm-tree the oil is conducted to an oil transport station managed by two 20-year-old women. The transport section was equipped with three motor-driven pumps (estimated at 100 horsepower each) in a concrete building about 20 by 40 feet. Next to the building there were banks of gas separators. What amazed me was the claim that this building and its set-up were completed in just 12 days during 1972.

The do-it-yourself spirit was amply demonstrated in Da-gong, particularly in the ways in which natural gas, a by-product of the oil pumping, could be utilized until the completion of a gas pipeline to Tientsin. One plant specialized in making seven types of electric light bulbs for household and automobile usage. The workers' equipment was not fancy, but it embodied the fundamentals of automation. The idea of making electric light bulbs is a good one, since the blowing of the bulbs consumes large quantities of gas.

Calcium carbide, to be used for the generation of acetylene gas needed in welding, was made in another subsidiary plant. The raw materials comprising calcium carbide consisted of 28 per cent coke and 72 per cent

An aqueduct provides the needed water supply at Dazhai. Photo by Judy Polumbaum.

clam shells, which are abundant in Da-gong. Gas was used to preheat the ingredients, followed by a high-temperature firing with an electric arc.

A third plant we visited utilized gas in a rotary kiln to fire clay pellets into hardened chunks, to be used as an aggregate of concrete in place of rocks and sand. On that part of the Chinese coastline there is no rock or sand, so they must be shipped from far away. The method of firing clay pellets reduced the cost of concrete almost tenfold.

Aside from these cost-saving programs, the people at Da-gong have also managed to grow eight million pounds of grains and 300 million pounds of vegetables since 1966. They certainly tried hard to conform to the national policy of self-sufficiency in basic commodities.

A Simplified Growth Plan

Considering the self-sufficiency achieved in endeavors running from agriculture to oil production, there was ample reason for the late Premier Chou En Lai to proclaim two years ago that China would catch up with the industrially advanced nations by the end of this century. The obvious method would seem to be a transfer of workers from farming to industry. This appears to be what the entire nation is geared to do in its gigantic self-reliance program.

As the base for this worker-transfer process, China needs a huge supply of tractors, other kinds of farm machinery, and fertilizer plants. Next in the sequence comes machine tools, transportation equipment, power-generation equipment, building-material plants, and light industries.

At the present time tractors such as the small 12-horsepower and the medium-sized 60-horsepower types are the most versatile and popular. Each 12-h.p. tractor, which requires one operator, is claimed to equal the productivity of seven buffalo and therefore can free six workers who would otherwise push plows behind these animals.

To produce this basic equipment I was told that there is at least one plant in every province, to enhance distribution and servicing of tractors and also dilute the risk in case of enemy attack. This consideration is probably applied to other machine tools as well. At one tractor plant we visited the name plates on the production equipment read like a catalog of Chinese cities, including such remote places as Baoji, Kunming, and Haerbin. Most factory personnel, however, took pride in their ability to make their own equipment and thereby solve their production problems. The most impressive examples are the homemade transfer machines such as those developed by the two tractor factories we visited. These transfer machines are used to fabricate complicated machine parts, such as gear boxes for the tractors, by carrying them through sequential work stations automatically. At each station the machine parts receive a certain combination of machining. Thus, a raw piece is completely finished after a single pass through the machine.

The transfer machines we saw are quite up to date, complete with hydraulically controlled work stations and relay-operated central controllers. Further examination showed the quality and complexity of these machines to be quite comparable to those used in the automobile plants of Detroit, Turino, or Osaka.

At the Tientsin Tractor Plant, large areas were cleared to make room for a new transfer machine system which had been planned by the Tientsin Factory Planning Institute. The equipment was to be furnished by a Shenyang transfer machine factory. Some of the early arrivals were being installed and wired by a group of electricians under the supervision of a young forewoman while we were visiting the plant. Since transfer machinery has been the primary equipment for automation since its introduction some 40 years ago (new computerized transfer machines may reduce the down-time slightly), the emergence of specialized organizations for dealing with this phase of manufacturing signals the maturity of China's production industry.

Despite all the activity in the farm-equipment plants and the impressive rows of products lined up outside ready for shipment, it is my impression that the impact of mechanization on the farm is still in its initial stages. As a growing number of farm hands are freed from the land to work in industry, an urgent need will develop to equip these workers with production tools, transportation systems, power supplies, and so on. Both the massive planning required and the spiralling growth rate that will ensue are stupendous to comprehend: The realization of Chou's proclamation would entail a growth for China similar to the industrial recovery of Japan or West Germany since World War II, but ten times greater because of China's sheer size. To translate this into simple dollar-value terms, let us use a round number of $10,000 per capita for the cost of tooling a modern industrial society, including roads, power generation, transportation, facilities, etc. Multiply this figure by the 800 million people in China. The total becomes eight trillion dollars, which is a large sum to invest.

If this amount is divided by the 25 years on a linear basis, it comes to over 300 billion dollars per year, or about the amount of the annual budget of the federal government of the United States. But if the growth rate in China is assumed to be 12 per cent per year compounded for 25 years, then by the year 2000 the annual production will be 100 times larger than the present capacity. If the annual capital investment also grows by the same rate it would correspond to a capital investment of 20 billion dollars per year now and two trillion dollars by the year 2000, to give a total accumulation of about eight trillion dollars. This would mean a capitalization of $25 per capita now, which is reasonable, but by no means easy, because China currently still depends upon agriculture to generate a large portion of the capital surplus.

This is, of course, a grossly simplified picture, but it serves as a reference for examining the few possible options. The key to this simplified picture is the assumed 12-per-cent average annual growth in capital equipment, including conversion from agriculture to industry, sustained over a period of time such as 25 years. How this growth is to be maintained, or even whether or not it should be maintained, is a major policy decision.

At one end of the spectrum of possible growth plans is an attempt to minimize the production of consumer goods while putting all industrial output into capital equipment for pushing industrialization at full steam over the entire 25 years. If done in this manner there could be a sudden switch-over at the end of the industrialization period from all-out regenerative industrialization to all-

Used drills for oil wells at Da-gong. The drills, which were lined up next to a well, had been made in Shanghai. Photo by Wendy Li.

out consumer-goods production. Such an extreme case does not seem likely, not only because it is impossible to make that sudden a change in product mix, but also because consumer pressure toward the last few years of industrial growth would become increasingly high and difficult to control — though this, of course, is speculation.

From a management point of view, China has achieved a most enviable position: a healthy trend of industrial growth with a relatively low consumption rate. It could be the philosophy of the Chinese government to hold the consumption rate down as much, and as long, as possible because it is always easier to relax the controls than to retract them in the future if the economic conditions do not meet expectations and the appetite of the people has been whetted.

The Chinese people come from a long history of national suffering and humiliation. To see the fast growth of such huge public projects as railroad expansion to remote places, the building of big ships, long bridges, gigantic factories, etc. could be far more exhiliarating and rewarding to them than the immediate improvement in their daily living standard. In fact, most people may be satisfied by the intoxication of this national growth for its own sake without consciously connecting the industrial growth with the improvement of their standard of living in the future.

Thus, it may be reasoned that the present Chinese policy of an all-out push for industrialization is a national consensus strengthened by the peoples' confidence in the success achieved so far. Seen in this light, the government policy of providing leadership in this direction represents a mutual reinforcement of a common goal with the people.

Self-Reliance and Technology Transfer

Before 1960, in the earlier phase of its industrial development, China relied heavily upon the technical assistance of the U.S.S.R. In the suburbs of Peking huge blocks of buildings were erected to house tens of thousands of Soviet technicians. It is rumored that the final break in the great Sino-Soviet alliance in the early 1960s was due to Khrushchev's insistence on having Chinese industry geared toward dependence on the Soviet supply system. When the Chinese balked at this policy, Krushchev pulled back all his technicians along with their blueprints and technical information. In the Shenyang heavy rolling mill, for example, the critical method for fabricating the giant roller to the desired surface hardness and finish was withheld by the Soviets. After six months of effort the problem was finally solved as the result of a contest conducted at several plants. In a Tientsin tractor plant the special machine for hot-rolling the rims of wheels was to have been supplied by the U.S.S.R. An experienced worker devised a home-made multi-staged cold press.

Now these efforts are related with pride; the Russian episode was indeed a lesson well learned. But Chairman Mao is a pragmatic man. He taught the Chinese the following slogan: Zi-Li-Gen-Shen; Yang-Wei Zhong-Yong. The first phrase means self-reliance, but the second phase (whose direct translation would be "Foreign made, China use") implies the adaptation of foreign methodology. This could be the reason why the Chinese purchased ten Boeing 707 airplanes two years ago and signed a contract worth several hundred million dollars with Rolls-Royce about a year ago.

All such transactions must whet the appetite of international traders, and indeed, China could use the industrial nations' know-how to help their workers to be more

efficient. However, it is very unlikely that China will follow the approach of the O.P.E.C. nations in making all-out purchases of turn-key factories. Nor will China go the route of some other emerging nations in developing labor-intensive industries that use low-cost labor to earn foreign exchange and temporary prosperity. By absorbing technology while remaining self-reliant, the Chinese seek to make sure that the technology they acquire is thoroughly digested by the workers and disseminated through the existing technology base.

The Chinese must have reasoned that only through a highly integrated plan would their entire nation be converted into a first-rate industrial complex in which the majority of the workers all have skill and efficiency. They must also realize that a long and arduous period, such as the remainder of this century, will be required to accomplish their objective. Thus, the expediencies for making fast but temporary gains are generally criticized as being the "Capitalist Road." Such deviations are weeded out by popular pressure which in some respects is not unlike what brought President Nixon down during the Watergate era.

In essence, the major difference between China and the United States is in the making of national plans. During the past two centuries the United States has made the fastest growth in all human history by emphasizing free enterprise. It became our way of life. What made free enterprise possible was the combination of political, social, and environmental factors that gave the American people access to a major portion of the world's resources. With it, entrepreneurs devised a multitude of ways to raise the U.S. "life style" but in the process they reduced most of the resources to problematic waste. So long as private enterprise worked well, there was no need to make national economic plans, and consequently there were none.

What faces the U.S. now is a hard realization of dwindling natural resources in conflict with a desire to maintain the established life style. At first there was confidence that free enterprise could do anything, that it could develop the new technology to exploit substitute resources. But the experience of the past few years suggests that private capital dries up quickly when the risk of new enterprise becomes high, influenced by dwindling resources. To have, or not to have, a national economics plan is therefore our dilemma.

China is learning from our past. The late Premier Chou made it clear that while China is determined to catch up with the West in industrial development there will be no traffic-choking private automobiles. That nation is conducting itself the way we would plan for a space station. Viewed in that manner, the pioneering effort of China to make the best of its environment deserves our continuous attention.

Epilogue

As this paper wound its way down the path to publication, China experienced a sequence of calamities that was capped by the loss of Chairman Mao. While the world honors Mao as an outstanding political figure of the twentieth century, there is universal anxiety as to what his passing may do to China. Will the succession of leadership bring about turmoil — specifically a power struggle among the different factions, radical versus moderate? Will the international alignment of China drift from friendship with the United States back to solidarity with the Soviet Union?

I share my grief for the passing of Chairman Mao with all my friends and relatives in China; I feel as if he had been my own uncle and teacher. However, in accepting his death I admire his teaching and leadership even more than before, because a stable society depends on the general level of political awareness among the people rather than on having a leader to follow. Floating on a sea of public will, various political aspirants will struggle to gain recognition, or failing to do so, may be discredited. Though Chairman Mao did not leave a clearly established heir, he has instilled in the minds of the people a spirit of self-reliance in economic development and in political awareness. With this in mind, I am quite comfortable about the future leadership of China and about the further development of Sino-American friendship.

Yao Tzu Li was born and grew up in Peking. He received his M.S. and Sc.D. in aeronautics from M.I.T. and then returned to China in 1940 to found an aircraft engine factory under a licensing arrangement with Curtiss Wright Aeronautics Company of Paterson, N.J. He returned to M.I.T. in 1947, first as a Research Associate, and since 1961 as Professor of Aeronautics and Astronautics, serving as Director of the Man-Vehicle Lab and as Chairman of the Instrumentation, Control and Guidance Division. His activities outside of M.I.T. include the foundation of two industrial firms: the Dynisco Instrument Company and Setra Systems, where he serves as Chairman of the Board. Since 1973 he has directed the newly founded M.I.T. Innovation Center, an N.S.F.-supported experiment that seeks to train students to be innovators and entrepreneurs.

What's a Nice Physicist Like You Doing in an Environment Like This?

In the card catalogue of Canada's largest science library, the index sub-headings under the classification "Physics" start with "Abbreviations," move on to "Collected Works," "Early Work to 1800," "Experiments," and so forth. The sub-heading "Environment" is conspicuous by its absence. In librarians' eyes, at least, there is no connection between the two fields.

The implied absence of a relationship between physics and the environment is not a mere quirk of book-cataloguers. Although most people with training in the sciences realize that there are connections — sometimes tenuous — among them, the link between physics and the environmental sciences seems more nebulous than between most others. Many believe that the environmental sciences deal solely with chemical, biological, and zoological problems of pollution. But environmental science is in fact a good place to demonstrate the interrelatedness of all the sciences. This connectedness can be tested by studying the terms an environmental indexing service uses to classify articles and books dealing with the environment. There are, of course, keywords dealing with the biological and social sciences which have traditionally formed the basis for environmental studies, such as *bacteria, predator control, aesthetics,* and *law (environmental).* But there are also dozens of keywords which relate directly to physics, to say nothing of those indirectly associated with it. Some of these keywords are *lasers, noise* (in terms of standards, effects, levels and measurement), *energy, heat* (in terms of exchange, recovery and transfer), *atomic radiation* (in terms of doses and standards), and so on. Obviously, the list could be greatly extended. Perhaps less obviously, many other keywords such as *oceanography, atmospheric diffusion, remote sensing, solar energy,* and *water temperature,* depend on physics for important parts of their concepts or methodology.

So there is a tie between physics and environmental sciences. Of course, the fact of a connection between subjects A and B doesn't necessarily mean that knowing A will help in solving the problems of B. But it is my contention that there is — far more than we have generally understood — a symbiotic relationship between physics and environmental science. In this article I will illustrate some of the ways that physics can help measure and control the environment — ways which have escaped physicists and environmentalists alike.

The Not-so-Simple Measurement of Oil on Water

Physicists approach environmental problems from many different points of view, but most will begin by focusing on measuring quantities of interest. The trouble is that many aspects of the environment turn out to be immeasurable, as well.

For instance, far more issues complicate the problem of detecting oil spills than the mechanism and effects of a black liquid spreading over water. There are social and ethical issues such as why the oil was being transported in the first place, and what it was to be used for. Other issues deal more with engineering, such as navigation

Physical property (units)	*Specific gravity at 22° C.*	*Viscosity at 22° C. (centistokes)*	*Viscosity at 30° C. (centistokes)*
Range for typical crude oils	0.79 to 0.93	4.08 to 255	2.76 to 113
Average for typical crude oils	0.857	90	41
Average for sea water	1.024	1.04	0.78

[1] At a frequency of 1 megaHertz.
[2] In visible range.

A table such as this typifies a physicist's approach to measuring an environmental problem. Here the purpose is to discover the differences between sea water and crude oil which may be measurable when oil is floating on the sea. Differences abound, and the problem is simply to find parameters which can be measured from the perspecitves readily available during an oil spill incident. Dielectric constant turns out to be one of these, and the author describes a submersible "capacitor" which is proposed for measuring the depth of oil slicks thicker than about one-half centimeter.

Herbert Inhaber
Advanced Concepts Centre
Environment Canada

Environmental science is no exception to the truism that from their unity the sciences gain strength

equipment used in the ship and the architecture of its hull. Many are biological — the effect of oil on the fauna and flora of the ocean and on wildfowl which land on it. Physics can deal only indirectly with most of these questions.

In a typical oil spill, we generally want to know such things as the thickness of the oil at various points, the size of the oil slick, and where it is heading. This is practical knowledge: it helps us to minimize the danger to wildlife and beaches, for armed with it we can then put our clean-up efforts to their best use.

Although detecting oil on sea water may seem simple, the methods are by no means obvious. An analogous situation occurs when a very thin film of vegetable oil is poured on a glass of water. If we look at the glass from the side, we can usually tell that oil is on top from the "break" between the two liquids. However, if we look at it from the top, we find the oil almost invisible. The situation is similar with oil on the ocean, which we often observe only from above. True, oil generally is darker in color than water, but in thin films it appears to have little or no color.

One physicist's approach is to construct a table such as the one on this page, in which are listed some physical differences between sea water and crude oil. The important rows are the last two, since by using them we may be able to tell which quantities to measure in detecting oil on water, and which to avoid.

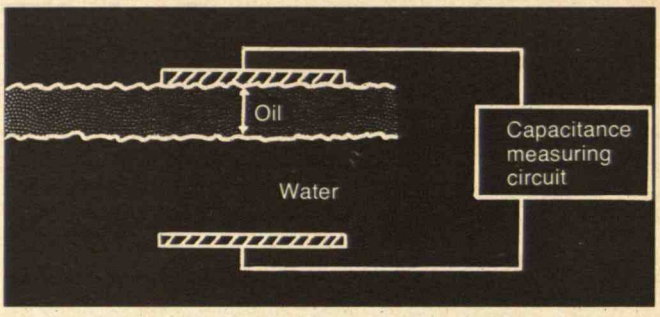
Note that *ranges* are shown in the first row for some quantities. The variable composition of oils produces a wide range of physical characteristics. This variability makes comparisons more difficult: we would prefer to compare one number for oil to one number for sea water. However, we can circumvent this problem to some extent by considering an average value for crude oils, as shown in the second row. Some oils obviously won't cooperate by having properties near this average value, and these oils must be considered more carefully.

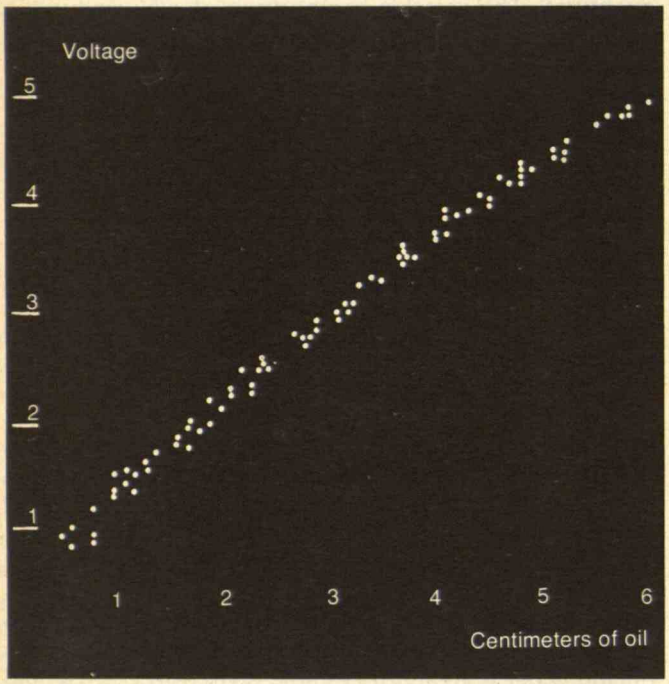
The comparison between the second and third rows — the characteristics of this "average" crude and those of sea water — is a key to the approach of a physicist when tackling environmental problems. When the difference between values of a property for oil and sea water is small, the chances are that the property will not be a useful way to differentiate between oil and water. It is true, of course, that oil and water can be differentiated on the basis of many of their properties. But when these properties are very close in value, the determination usually requires precise laboratory conditions not usually found in environmental measurements. To obtain dependable identification under field conditions, we need to concentrate on parameters where the difference between oil and water is great (an example is viscosity). We would probably not measure differences in specific gravity, index of refraction, or emittance.

One method of solving the problem of detecting oil on water makes use of the different dielectric constants of the two liquids. To measure the dielectric constant, we

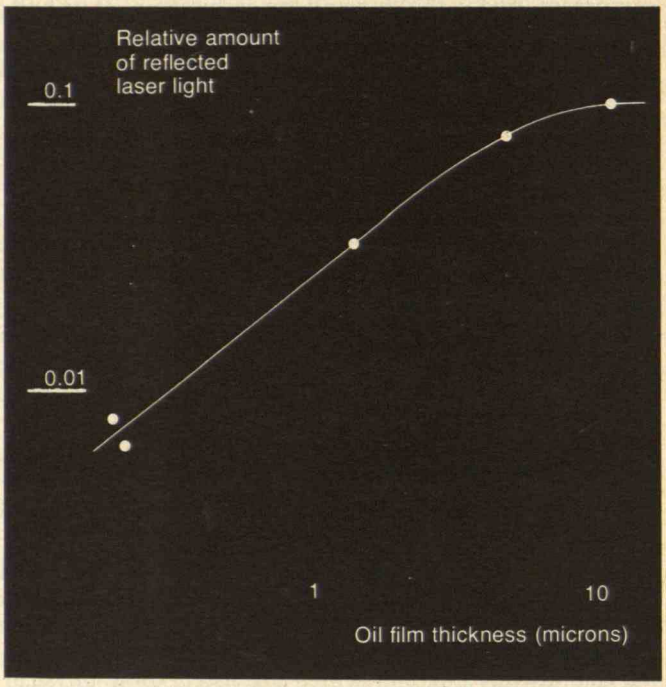
Surface tension at 22°C. (dynes per centimeter)	*Thermal conductivity (calories per second per cm.²)*	*Dielectric constant (relative to air)*	*Conductivity (millimhos per cm.)*	*Index of refraction [2] (relative to air)*	*Emittance (relative to perfect black body)*	*Fluorescence*
24.4 to 31.8	3.1×10^{-4} to 4.2×10^{-4}					
28	3.3×10^{-4}	2.0	Insulator	1.44	0.97	0 to 20 per cent
73.02	15×10^{-4}	7.8 [1]	16 to 60 (conductor)	1.34	0.993	None

The physicist's approach to capitalizing on the fact that the dielectric constants of oil and water are very different is to deploy a capacitor as a device for measuring the thickness of a water-borne oil film. Two plates are suspended, one atop the oil and the other in the water, and it is a simple matter to measure the capacitance — a function of the dielectric constant — between them.





Laboratory tests of the capacitor circuit shown opposite confirm that the voltage between plates (which is proportional to the inverse of the capacitance) varies directly and consistently with the thickness of a water-borne film of crude oil, down to film thickness of about one-half centimeter. With this laboratory-based calibration, a capacitance-measuring circuit can be effectively deployed as an important environmental tool.



Thin coatings of oil on water affect the amount of light reflected from the fluid surface. The phenomenon is described by the Lambert-Beer law of light absorption: reflected light decreases with increasing thickness of a light-absorbing medium on the water surface. Oil is such an absorber, and the reflected portion of a narrow beam of laser light turns out to be an effective measure of oil film thickness in the range of 0.1 to 7 microns. The reflected laser light tends to "saturate," or become non-linear on this graph, at about four microns. This is due to strong absorption of laser radiation within the film at this point.

compare the capacitance (or ability to hold electric charge) of a capacitor filled with the substance we are considering to its capacitance when filled with air, which is used as a reference. Water, for example, has a considerably higher dielectric constant than air and many solids. Oil has a much smaller dielectric constant than water. But there is a long way between noting the characteristic values of dielectric constants from research papers and actually using these differences to measure an environmental condition. How can we use the rather striking difference in dielectric constant between oil and water?

If a capacitor containing water has part of the liquid replaced by oil, its capacitance will decrease. We can use this physical fact to find out how thick oil is at any point on an ocean. We measure the capacitance where there is no oil, and compare it to the value where there is some suspected. If the two values are unequal, there is probably oil on the water. The actual measurement we make is the voltage (or potential difference) between two plates, one afloat on the surface and the other suspended below it, acting as plates of a capacitor. The voltage is inversely proportional to the capacitance.

This method seems to be confined to relatively thick films — significant differences are hard to measure if the oil is thinner than about one-half centimeter. When the slick is thin (corresponding to most observed conditions) we can turn to a recent invention of physics, the laser, which — when first invented — was described by some as a solution in search of a problem. Laser light reflects off the water-oil interface with a comparatively small

amount of attenuation, and its extremely sharp bandwidth and narrow beam make detection simpler.

The physical principle correlating oil thickness and attenuation of the laser light is the Lambert-Beer law of light absorption: the ratio of the detected light to the incident light decreases exponentially as the thickness of the absorber increases.

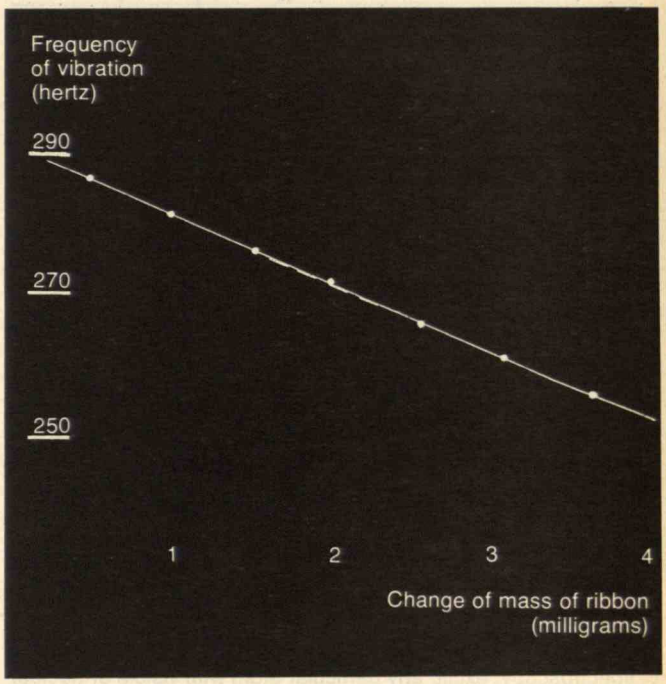
The effect can be calibrated in the laboratory, using a laser reflected off an oil-water surface whose oil depth has been previously calculated. The measurement is sensitive to changes in oil depth up to about seven microns, indicating an approximate upper range to the method. A laser beam deployed from a helicopter or aircraft over polluted river or ocean water produces the same effect, and the thickness of the oil film is indicated by the laboratory calibration.

There remains a gap between the relatively thin films measured by this method and the thick ones (one-half centimeter or more) which can be studied by the capacitance method. This gap remains for physics to fill — perhaps by using other types of lasers, or even a completely new method.

Air Pollutants in Parts per Trillion

Consider another example of physics applied to environmental science: measuring the extent of air pollution. The brew we call air pollution consists of a great many ingredients: sulfur dioxide, oxides of nitrogen, hydrocarbons, particulates, and so on. One physical or chemical principle cannot be used to measure all the components simultaneously.

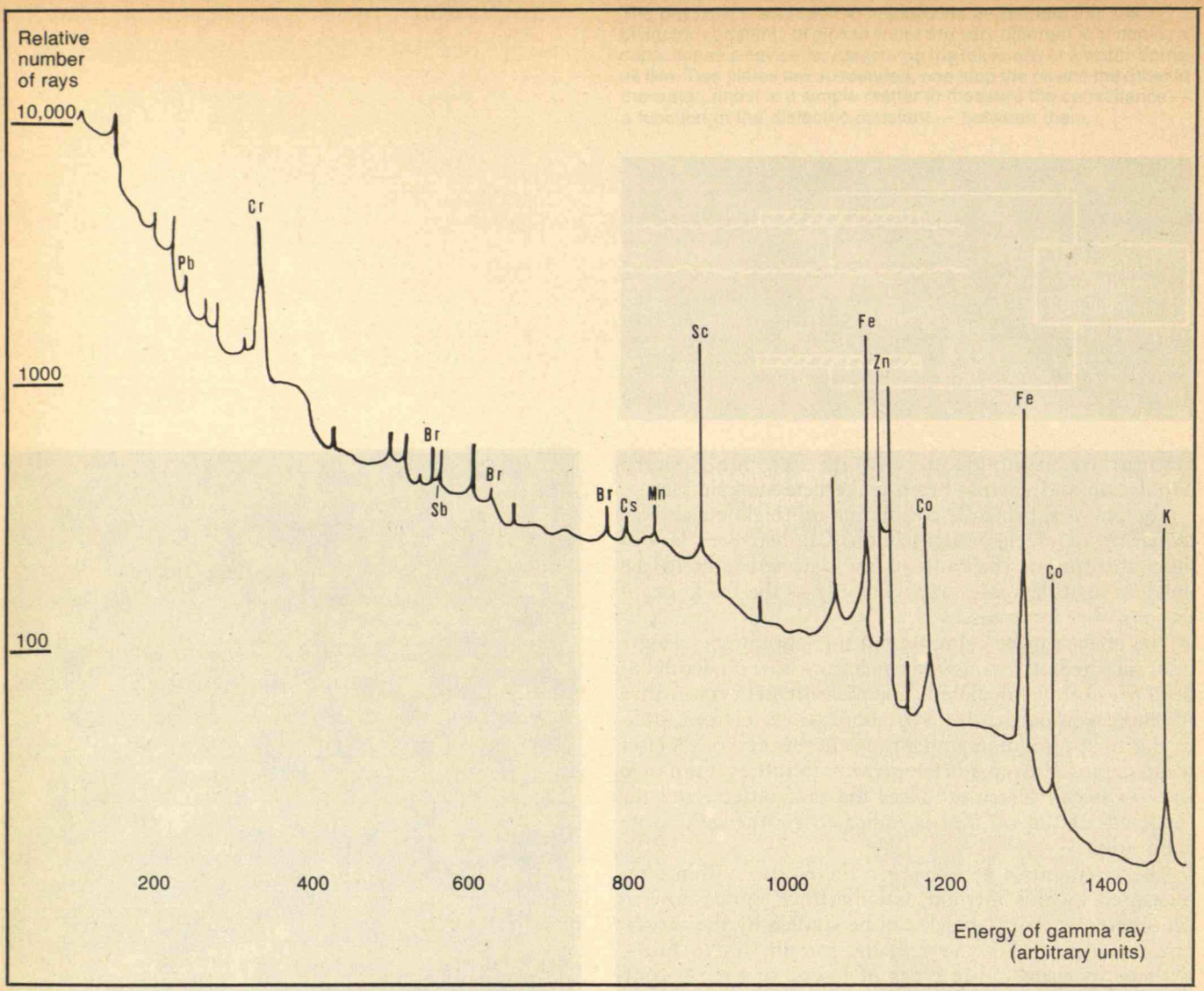
At present, the total mass of particulates in the air — one of the most important pollutants — is found by drawing a known volume of air through a filter and measuring the difference between the mass of the filter before and after the filtration. A cheaper, faster, and more accurate method would take account of the fact that a string which is taut has a characteristic (or resonant) frequency when it is plucked. A thin string on a violin or guitar will produce a higher note (that is, a note of higher frequency) than a string which is thicker. The resonant frequency varies as the inverse square root of the mass. When the mass of the string increases, the frequency falls. To put this physical principle to work measuring air pollution, we connect particulate matter with resonant behavior. Substituting a plastic ribbon for the string produces a greater area on which particulate matter can fall. The ribbon is exposed to outside air, and its resonant frequency is measured as pollution descends. Since frequencies can easily be measured down to hundredths of a Hertz, we can find the increase in mass due to particulates down to small fractions of a milligram — an accurate method of finding levels of air pollution over a short or long time.



Physicists are familiar with the fact that the resonant frequency of a taut string varies inversely with its mass — the heavier the string, the lower its frequency. This principle can be applied to measuring air-polluting particulates. Measure the resonant frequency of a clean ribbon, expose the ribbon to polluted air for a specified period and measure its resonant frequency again. The change in the mass of the ribbon due to particulates which have accumulated on it can be determined in terms of the change in its resonant frequency.

Physics of the Atom

Atomic physics and radioactivity also can be used as precise tools to identify many specific environmental pollutants. For example, measurement of mercury concentration in fish, and the effect of this pollutant on humans, has produced a great deal of controversy. The problem was different from those of most other pollutants because mercury concentrations were of the order of parts per billion (p.p.b.), and most conventional methods of analysis cannot measure so low a concentration as this.



Most readers of *Technology Review* are familiar with the principles of spectroscopy: excite any particular atom with visible or nuclear energy, and it emits light or energy in amounts and frequencies characteristic of that atom — and no other. Hence the power of spectroscopy in the identification of trace amounts (parts per billion or even parts per trillion) of pollutants. This drawing shows the peaks of emissions due to neutron bombardment of a sample containing many different elements; the position of the peak identifies the element, and the height tells its concentration in the sample. For example, in the region of 850 energy units we see evidence of a comparatively large amount of scandium but lesser amounts of manganese and cesium.

But such problems are of increasing importance. The possibility of harm to health from very small amounts of unusual elements has become greater with the increasing use of more exotic materials in many industries.

We can use atomic physics to identify many of these elements, even when their concentrations are as low as the parts-per-trillion (p.p.t.) range. The method — called nuclear spectroscopy — involves bombarding an atom (or molecule) with a sub-atomic particle or ray. The struck atom is disturbed from its stable state and in turn emits another particle or ray. By measuring the energy and other characteristics of this particle or ray, we can tell from what element it was emitted.

Many different particles and rays can be used to bombard atoms — protons, electrons, photons of visible light, x-rays, gamma rays, and others. Each type of particle has particular advantages, depending on the element to be detected. For example, neutrons can penetrate the outer electrons and hit the nucleus of the atom more easily than most other particles because of their electrical neutrality, so they are chosen where perturbations of the nucleus are of special interest.

This method can be used to detect small concentrations of elements in a sample of air, water, or organic material. Mercury, for example, can be detected at the 0.3 p.p.b. level, and many other elements can be found at even lower levels. We can thus detect potential environmental problems before they cause harm.

The Positive Contributions of Physics to Control

Up to now, we have been primarily discussing how we can use physics to assess the state of the environment. If assessing were all it could do, physics would be a weak weapon in the battle against pollution. But we can use physics to control the environment as well as measure it.

Consider the problem of purifying water coming from municipal or industrial sewers. We usually employ chemical treatment such as chlorination to eliminate bacteria

and viruses. However, water purified by chlorination is harmful to many forms of marine life, including shellfish. Other methods can produce virus-free water without this effect. One is irradiation by a strong beam of ultraviolet light, which is effective because it has greater energy (per photon) than ordinary visible light. The exact decrease in the number of viruses will depend on the power of the light and its energy (frequency).

The mechanisms by which ultraviolet light acts to eliminate the viruses are not all known. One possibility is that the light, being in a concentrated beam and having more energy than ordinary visible light, breaks the chemical bonds between atoms and molecules in the virus by changing the energy states of their electrons. An analogous process has been devised using high-energy electrons, and that is now being tested on a large scale in Boston (*see* Technology Review *for October/November, 1974, pp. 14-15).* These examples illustrate that physics can control environmental conditions, not just measure them.

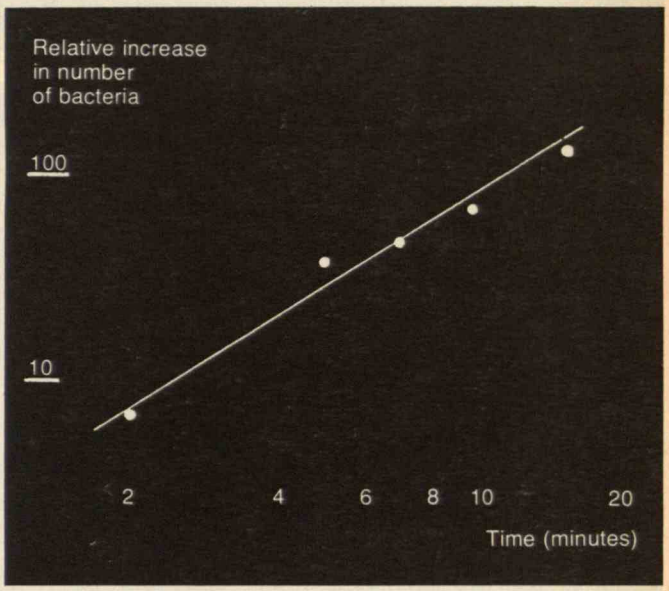
Sound is More Than Noise

When we think of sound in an environmental context, we inevitably think of noise. But sound is not always an environmental annoyance; it can be useful. One somewhat unglamorous use is in increasing the accuracy of bacteria counts in sludge from sewage treatment plants. The sludge is broken down chemically by bacteria, and in order to find the effectiveness of the treatment we need to know the number of bacteria present. The sludge is usually so thick that counting bacteria is difficult. If we could somehow break up the goo we could count more accurately. One method of doing this is called "sonication." It uses standing sound waves in a wire stretched through a container of sludge as an agitator.

Pollutants Measured by Resistivity of Fish

Electricity is by far the most common physical measuring tool, and so it is logical to assume that electricity (and magnetism) permeates all of environmental physics. But we can use electrical measurements in more than the standard ways. For example, consider the relation between fish and electricity.

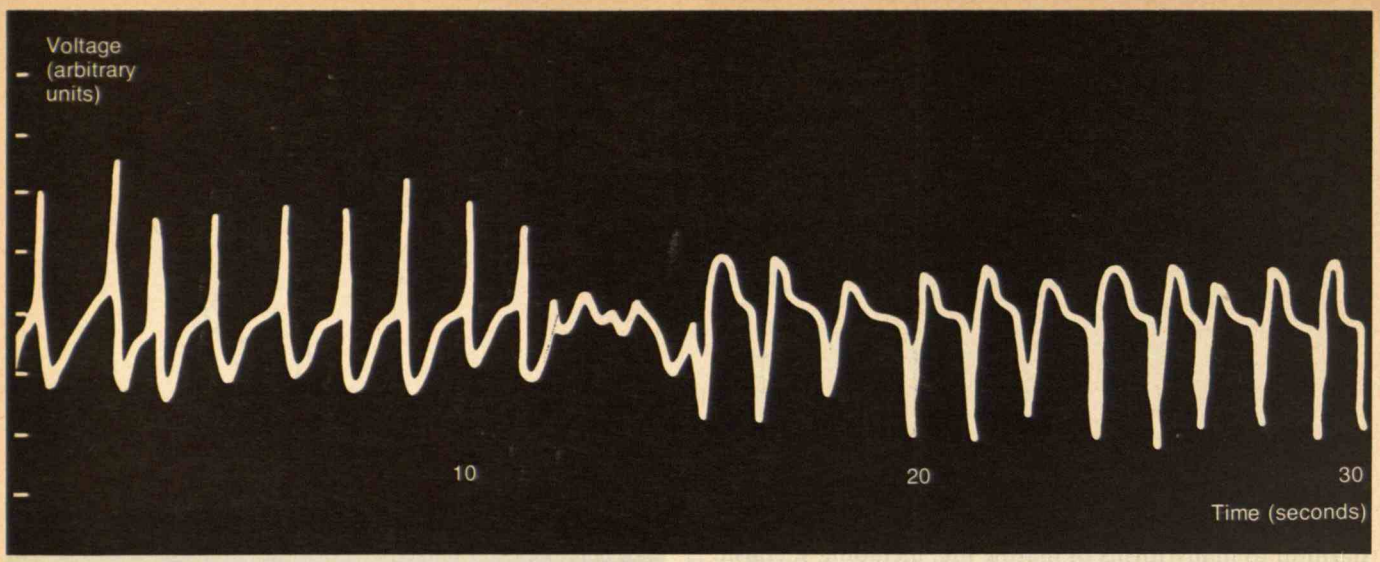
Fish might be considered, in the language of economics, a "leading indicator" of water pollution. They accumulate pollutants which are absorbed at the lowest end of the food chain; as a result, concentrations of pollutants in fish tend to be much higher than in the surrounding water. For example, the first cases of mercury pollution

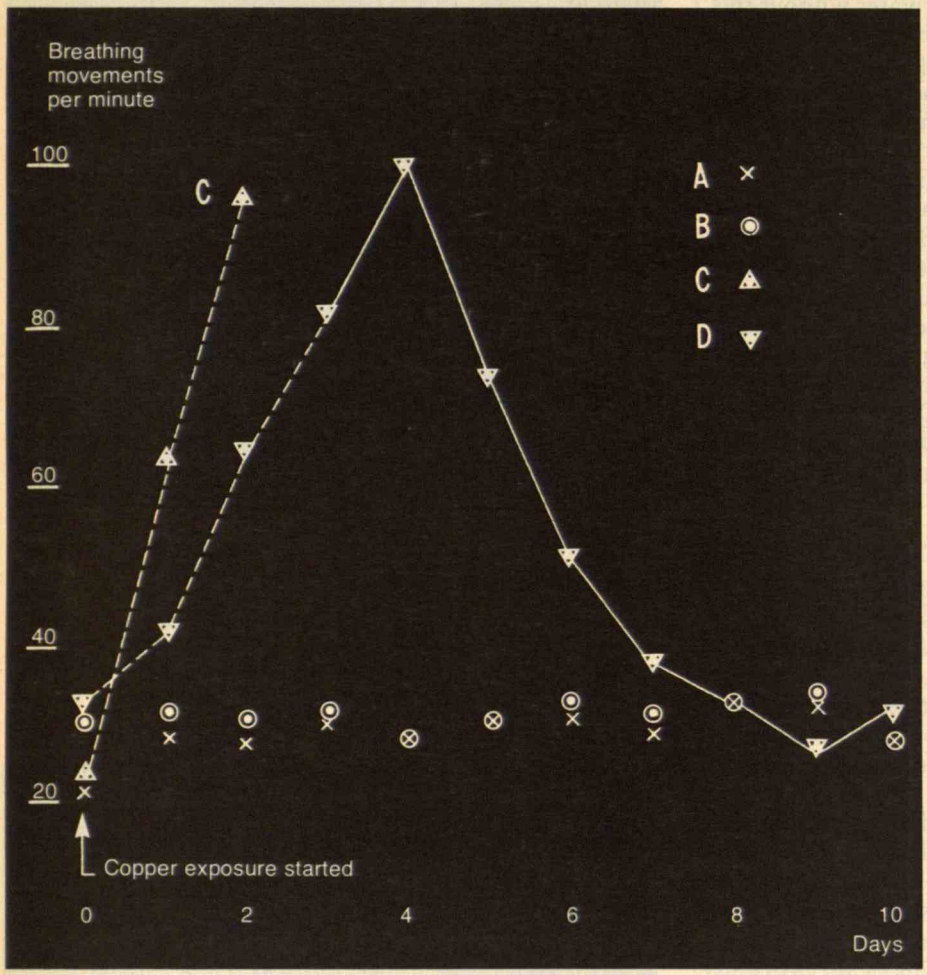


How many bacteria are present in a sample of sewage-treatment sludge? "Sludge" is a descriptive term and accurately counting bacteria in such heavy homogenous mixtures is impossible. Hence the process of "sonication" — the use of sound waves to break up sludge and expose bacteria. The chart shows the increasing number of bacteria which can be detected in a sludge sample exposed to increasing periods of "sonication."

Detection limit (parts per billion)	*Elements*
0.0009	Manganese, Indium
0.003	Cobalt
0.009	Bromine, Gold
0.03	Argon, Vanadium, Copper, Arsenic, Silver, Iodine, Tungsten
0.09	Sodium, Germanium, Strontium, Uranium
0.3	Aluminum, Chlorine, Potassium, Mercury
0.9	Silicon, Nickel, Platinum
3.0	Phosphorous, Titanium, Zinc, Tin
9.0	Magnesium, Calcium
30.0	Fluorine, Chromium
300	Sulfur, Lead
900	Iron

Spectroscopy is a powerful tool for identifying trace elements of pollutants. The table shows the limits of detection for some common elements by the "neutron activation" method — bombardment of unknown materials with neutrons.





How often does a fish "breathe"? The chart at the top shows the answer — the change in voltage across a tank of water corresponding to the intake of water by a bluegill in the tank. (The fish turned around in the tank at the 12-second point.) The fish's opercular movements ("breathing") cause the voltage change because fish and water have different electrical resistivities. This method turns out to be important to environmental science because water pollution affects the rate of fish's opercular movements. The chart below shows the effect of copper added to water (0.5 milligrams per liter per day) in which two fish were living: the rate of "breathing" increased dramatically; one of the two fish died after two days of the experiment, and the other made a successful adjustment to the new environmental conditions to which it was exposed. (The horizontal dots are the results with a control group to whose water no copper was added.)

were found after people ate the contaminated fish, not by measurements in the water from which the fish came.

We can use electrical measurements to indicate the behavior of fish. If we can correlate that behavior with contamination, we can indirectly measure pollution. One way is to put fish into a tank across which a small voltage is placed. Since fish do not have the same resistivity as water, their opercular movements — "breathing" — cause small changes in the observed voltage.

The rate of "breathing" by fish is related to the concentration of pollutants in the water: the illustration shows the effect of a small amount of copper. If we can extend this type of measurement to other types of pollutants, we may have a valuable — if unconventional — measuring tool to determine their effect on fish. While the rate of breathing is only one aspect of fish health, it is a clear indicator. This example shows that although electrical measurements are almost universal in their scope, we can still use them in unusual ways.

A different application of electrical measuring techniques from physics has not been so successful. When we discuss the possible extinction of certain species of wildlife, or even their diminution, we are relying on very crude and inexact data on their numbers. Although those

involved are often experts, the task of counting animals and birds that flee from humans is almost overwhelming. National and even international policies are made on the basis of wildlife counts, but as yet the data are assembled in ways that were available and presumably used thousands of years ago. Can physicists and engineers, using means ranging from photogrammetry to radio detection, help with this problem? They are trying, but so far the effort has been miniscule.

The Unity of Physics and of the Sciences

In my examples, a relatively simple principle of physics has been used to measure an environmental problem which is difficult to evaluate in other ways. Many of these principles are interrelated. The laser light used to measure oil slicks, and the ultraviolet light used to kill viruses, are just different aspects of electromagnetic radiation. Though sonication is a phenomenon of sound, the standing waves on which it is based are those used to find the resonant frequencies in the plastic ribbon experiment. The mechanics of the solid materials used in buildings affects the amount of sound (or noise) energy which enters them, just as mechanics is intimately bound up with the standing waves and resonant frequencies used to identify and measure pollutants.

The fact that we have presented specific experimental cases does not mean that the philosophical ramifications of physics are not important in the broader consideration of environmental issues. For example, the first law of thermodynamics can be roughly translated as "there is no such thing as a free lunch." That is, for every improvement in our lives we generally have to pay a price somewhere, and the bill is often charged to the environment. This law puts on a more mathematical footing something which to many of us is common sense. Similarly, the second law of thermodynamics, predicting a continually increasing entropy or degree of disorder in the universe, also has profound environmental significance.

Part of the folklore of physics is that "physicists not only can do anything, but that they can do it better than anyone else," writes M. Goldberger. Physics has been remarkably successful in its self-defined confines, but there has been only slight evidence of physicists' success outside their own field except in a national or international crisis, like war. The problems we are facing with our environment have not yet reached that crisis stage, and the potential role of physicists has not, therefore, been fulfilled. Physics should be accorded a place, along with the life sciences, chemistry, mathematics, and other fields, in interdisciplinary groups formed to work on environmental problems. Until now this teamwork hasn't occurred on any significant scale, even at the university level, and there has been even less realization of the potential contribution of physics on the governmental and industrial level. Just as the structure of science would be distorted if one of its components were removed, our attack on problems of pollution will be incomplete without the use of every field of knowledge which bears on it.

Suggested Readings

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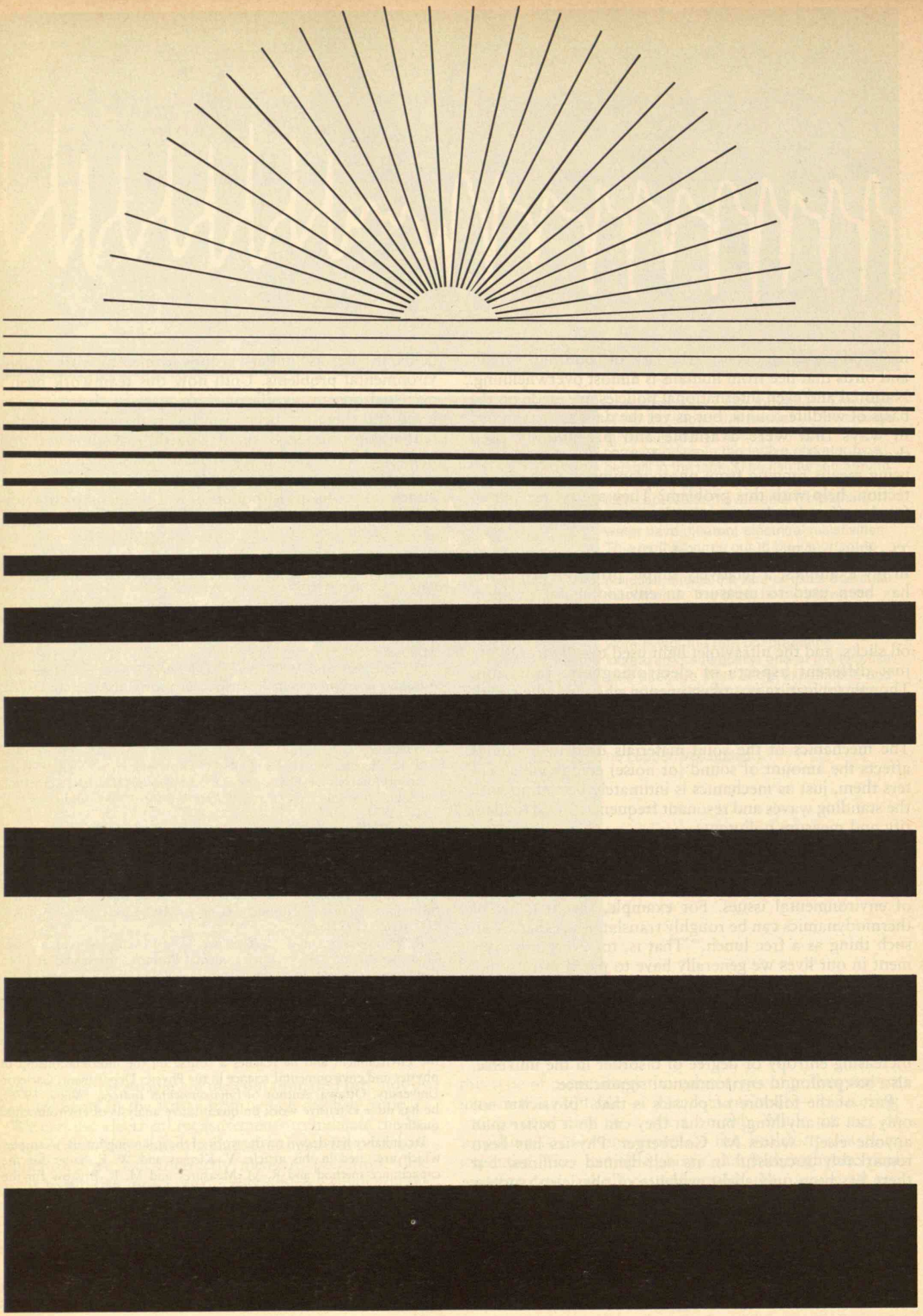
Herbert Inhaber is a policy analyst with the Canadian Department of the Environment and he teaches a course on the interrelationship of physics and environmental science in the Physics Department, Carleton University, Ottawa. Author of *Environmental Indices,* (Wiley, 1976), he has done extensive work on quantitative analysis of environmental quality.

Dr. Inhaber has drawn on the work of the following for the examples which are cited in this article: V. Klemas and W. E. Sauer for the capacitance method and R. M. Measures and M. R. Bristow for the laser absorption method of measuring the thickness of oil layers; T. Gast for the standing-wave method of measuring particulate pollutions; S. K. Bhagat, W. H. Funk, R. H. Filby, and K. R. Shah for the neutron activation method of trace element analysis; A. R. Williams, C. F. Forster, and D. E. Hughes for the sonication method of analyzing sludge; and W. A. Spoor, T. W. Neiheisel, and R. A. Drummond for the analysis of fish respiratory action. He also acknowledges the assistance of Ugo Lama and Edmund Robertson in preparing this manuscript.



John B. Goodenough
Oxford University

The sun's energy can be bent to man's use in a great many ways. Traditional strategies are being reassessed and a number of innovations in materials and design are appearing

The Options for Using the Sun

The sun's radiant energy arrives at the earth with a power density of approximately one kilowatt per square meter normal to the sun. Atmospheric attenuation, clouds, and the day-night cycle reduce the long-term average to less than a quarter of that. Nevertheless, solar energy is abundant: the total 1974 U.S. demand for electricity could be supplied by conversion plants of 30 per cent efficiency using sunlight collected from a total area equal to that of all the buildings in the country.

Direct sunlight may be focused and directed by lenses and mirrors. Sunlight is ubiquitous, a fact that can minimize transportation costs if collection is widespread. Finally, sunlight is directly convertible (with various efficiencies) to heat, electricity, fuel, and mechanical energy; and, aside from problems with architectural design, it is nonpolluting. Why then has solar energy been exploited only for special-purpose application? The answer is twofold:

— Although solar energy is abundant, its density is low, which makes its collection and conversion costly.

— The density of solar energy at any place on earth is variable in time, which makes energy storage an added requirement.

For these reasons, assessment of solar-energy utilization becomes largely a cost analysis of schemes for its collection, conversion, and storage.

An estimate of the economic obstacle can be obtained from a calculation of the average electric power generated by the radiation falling upon one square foot of the earth's surface. If the conversion of thermal energy to electric power has a typical efficiency of 20 per cent, this power is less than 0.005 kilowatt, so 200 square feet of collector surface are needed to produce a one-kilowatt average of electric power. Since the capital cost of a nuclear power station is about $800 per kilowatt, economic feasibility implies a collector cost of less than $4 per square foot installed, which is very low by any present standard. Today's photovoltaic-cell arrays, developed for space vehicles, have costs approaching $400 per square foot. Reliable cost estimates for conversion of solar energy to heat and heat in turn to electricity are not available, but a simple flat-plate collector for conversion to low-grade heat costs $4 per square foot installed.

Natural Collectors of Solar Energy

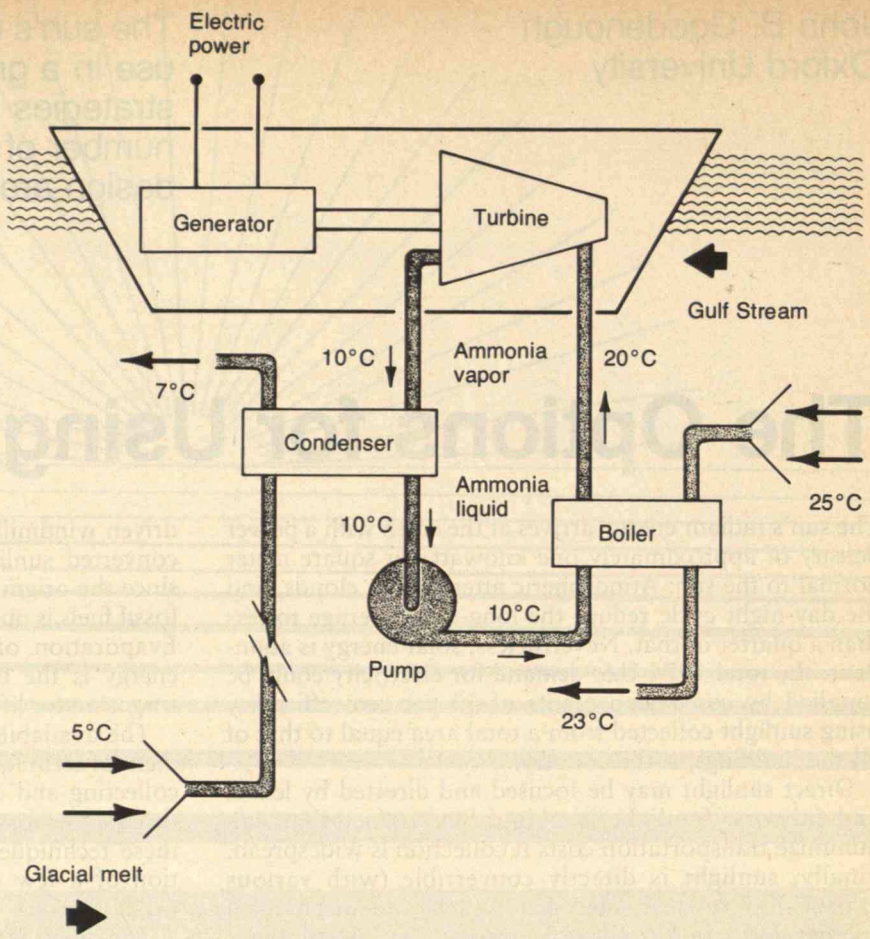
The utilization of solar energy is not new. Since early history man has used solar dehydration to produce salt, to preserve fruits, and to dry his clothes. Differential heating of the earth's surface produces wind, which has driven windmills and sailboats for centuries. Plants have converted sunlight to food and fuel by photosynthesis since the origin of life on earth, and the energy stored in fossil fuels is our inheritance from this process in the past. Evaporation of sea water by the absorption of solar energy is the basic source of rainfall — and hence of irrigation for life on land and of hydropower for industry.

The availability of cheap fossil fuels arrested development of techniques for exploiting nature's other modes of collecting and converting solar energy. However, as the demand for fossil fuels begins to exceed supply, interest in these techniques is being revived. Therefore, identification of a few of the seriously proposed schemes is in order.

The ocean is a vast collector of solar energy, converting and storing it as heat. (It also converts wind energy to the mechanical energy of its waves, and the exploitation of wave power is under active consideration.) Between the Tropics of Cancer and Capricorn, the surface of the oceans reaches a steady-state temperature of 25°C. Meanwhile, at depths as shallow as 1,000 meters in some locaions, glacial melt migrating to the equator from the polar regions provides a nearly infinite heat sink at about 5°C. As early as 1881, Jacques D'Arsonval, a French physicist, proposed that electric power could be extracted from a heat engine operating across part of this temperature difference, and such a system was patented in 1964 by Hilbert and James Anderson. The Andersons proposed a submerged boiler and condenser with ammonia as the working fluid; such a system is illustrated on the next page. The boiler would concentrate the diffuse ocean heat, extracting two calories from each gram of water and delivering 280 calories to each gram of ammonia, that being the heat of vaporization of ammonia at 20°C and 124 pounds per square inch pressure. The diffuse heat of the seawater is thus concentrated 140 times. Although the conversion efficiency of such a plant is low (5 per cent at best), the available energy is enormous, and special energy storage is not required. However, the temperature difference is small, which means that large flows of water are required. Building and anchoring cost-competitive heat exhangers that must operate for long time periods with such large flows of water present difficult engineering problems. Though ingenious engineering designs have been proposed, a practical design has yet to be demonstrated.

Since man's traditional fuels have been produced, directly or indirectly, by photosynthesis, it is not surprising that *biological conversion* of solar energy is seriously

A heat engine to exploit the temperature difference between seawater at the ocean's surface and seawater at depths of a thousand meters. The system, patented by Hilbert and James Anderson in 1964, would extract heat from the water and concentrate it in ammonia, the working fluid of an electric-power generator.



proposed. In its simplest form, the use of photosynthesis to generate fuels consists of growing, harvesting, and burning plants. A century ago, America depended heavily on this resource in the form of the "wood lot." However, biomass such as wood is inconvenient to harvest, store, ship, and use for heating and transportation. Today, technological improvements suggest approaches in which the biomass is refined to more convenient fuel products. Biomass — available, for example, in municipal waste — can be converted to a fuel gas containing hydrogen and carbon monoxide; this gas can substitute for natural gas, or it may be converted to methanol (a clean burning liquid that can be used as a gasoline additive, as feedstock for conversion to synthetic gasoline, or as a substitute fuel in its own right) by passing the compressed gases over a suitable catalyst. With minor modifications, such plants could also produce ammonia. One system, designed by Union Carbide Corp., converts to fuel gas 200 tons of municipal waste per day, the gas containing about 75 per cent of the energy of the waste.

Solar Collectors

Solar energy is today used as a source of low-temperature heat in a variety of applications: in greenhouses and solariums to stimulate plant growth; in sewage-treatment digesters to promote chemical reactions; in homes to provide space and water heating as well as air conditioning. With the aid of concentrators, it has also been used to obtain high-temperature heat. The French, for example, have constructed an ultra-high-temperature solar furnace in the Pyrenees.

Solar-heat collectors have three essential components: an absorber, a heat exchanger, and insulation (see the illustration on the page opposite). Their principle of operation is simple: solar energy (sunlight) is absorbed at a surface (the absorber), which grows hotter. A circulating heat-transfer fluid extracts heat at the higher temperature and delivers it to storage or to a heat engine. The efficiency of collection and conversion, which decreases with increasing temperature, is defined as the rate at which heat is delivered from the collector divided by the rate at which solar power arrives at the device. Together with storage capacity and storage duration, it determines the collector area required to perform a specified function. Therefore efficiency dictates the constraint on cost per square foot of installed collector.

Heat loss reduces the efficiency, but still air is a good thermal insulator, so heat losses to the surrounding air can be minimized by using a cover plate a short distance from the absorber. However, losses by heat conduction to this plate become considerable if the spacing is too small, and losses by convection due to air circulation between the plates become considerable if the spacing is too large. Even with optimum spacing of the cover plate, there remains infrared radiation from the absorber, which will dominate the heat losses unless optically selective absorbers or cover plates are used. Solar radiation peaks in the visible spectrum at 0.5 micrometers; it is well resolved from the infrared spectrum emitted from a hot absorber at temperatures less than 1,000 Kelvin (1,340°F), as can be seen from the illustration on page 66. A selective absorber is designed to capture the sunlight, but not emit heat as radiant infrared energy. Since the ability of a body to capture radiation at a given wavelength is equal to its ability to emit radiation, a selective absorber should act like a blackbody — that is, it should capture all radiation

— only over the solar spectrum; it should reflect infrared radiation. (The sum of the absorptivity, reflectivity, and transmission is unity, and an opaque absorber has zero transmission; hence to obtain a low absorptivity — which equals emissivity — it is necessary to have a high reflectivity.) A selective cover plate, on the other hand, should be designed to transmit the solar spectrum, but reflect the infrared radiation emitted by the absorber back into the collector. With a vacuum between them, the use of both a selective absorber and a selective coverplate should make it possible to extract 400°C. (750°F.) heat with over 50 per cent efficiency without the aid of a solar concentrator.

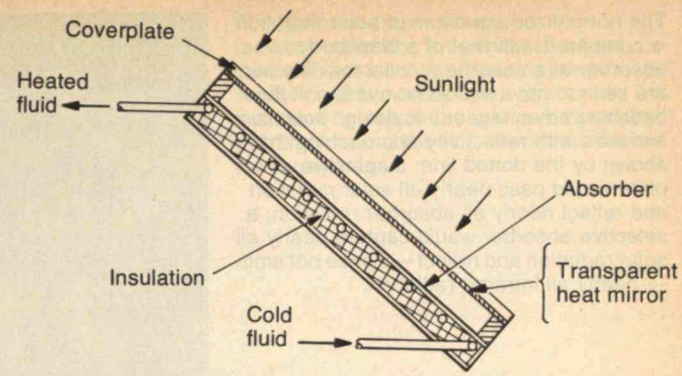
Selective absorbers consist of a smooth metallic sheet covered with either a thin semiconducting surface or a finely divided metallic powder. The smooth metallic sheet reflects infrared radiation and provides good thermal contact between the hot absorbing layer and the working fluid. The surface layer selectively absorbs sunlight.

Sheets covered with cermets — finely divided metallic powders imbedded in a transparent ceramic — reflect the longer wavelengths back out to space, but reflect the shorter wavelengths to other metallic particles in the surface; a large absorption occurs in the course of the multiple reflections.

Semiconducting surfaces absorb solar energy in a different way. The electronic structure of a semiconductor is characterized by a filled band of electron energy states (the valence band) separated from an empty band (the conduction band) by an energy gap. Electrons may be excited from the valence band to the conduction band by the absorption of a light quantum — a photon — that has energy greater than the energy gap. The electrons excited into the conduction band are mobile carriers of negative charge, and the "holes" they leave behind in the valence band are mobile carriers of positive charge. Mobile electrons or holes may also be present as a result of "doping" — the introduction of impurities.

In a selective absorber, the semiconductor undergoes both excitations of atomic vibrations and transitions of electrons between a filled valence band and an empty conduction band. Atomic vibrations absorb photons with longer wavelengths, and electronic transitions absorb photons with shorter wavelengths. The semiconductor transmits radiation having intermediate wavelengths, and the transmitted light is reflected by the metallic plate beneath. If the surface-layer semiconductor is chosen appropriately, the absorptivity due to electronic transitions may approach unity over the solar spectrum while the infrared emission from the hot absorber is low because it occurs at intermediate wavelengths where the semiconductor transmits radiation to the reflecting metallic sheet. Absorptivity-to-emissivity ratios of 10 to 20 can be obtained with inexpensive techniques.

Selective cover plates, or heat mirrors transparent to the solar spectrum, have been prepared in three ways: as $TiO_2/Ag/TiO_2$ sandwiches of controlled film thickness, as transparent conductors having a controlled number of high-mobility charge carriers (tin-doped indium oxide [In_2O_3:Sn] films), and as conducting microgrids having a 2.5-micrometer mesh and 0.6-micrometer-diameter grid lines of In_2O_3:Sn. The microgrid films increase transmission of the visible spectrum; but the degradation in reflectivity was disappointing. In the $TiO_2/Ag/TiO_2$ sandwiches, the titanium dioxide films act as antireflection and protective coatings, the silver film as the mirror. The silver film is made thin enough to pass the higher-energy solar spectrum but reflect the lower-energy infrared spectrum. These films have excellent reflectivity in the infrared and an adequate pass-band in the visible spectrum for window insulation on earth or solar-heat collectors in space (*see the chart on page 67*). The pass-band is a little too restricted for terrestrial solar-heat collectors having air between the cover plate and absorber. In the In_2O_3:Sn films, the energy gap of semiconducting In_2O_3 is large enough to pass sunlight, and the mobile electrons introduced by doping it with tin reflect the infrared radiation, but not the visible radiation. The pass-band cutoff for the solar radiation is controlled through the concentration of tin-atom donors of mobile electrons. The sharpness of the cutoff depends on the mobility of the electrons. In general, it is difficult to introduce mobile electrons into a transparent material without darkening it, but In_2O_3:Sn is an exception.



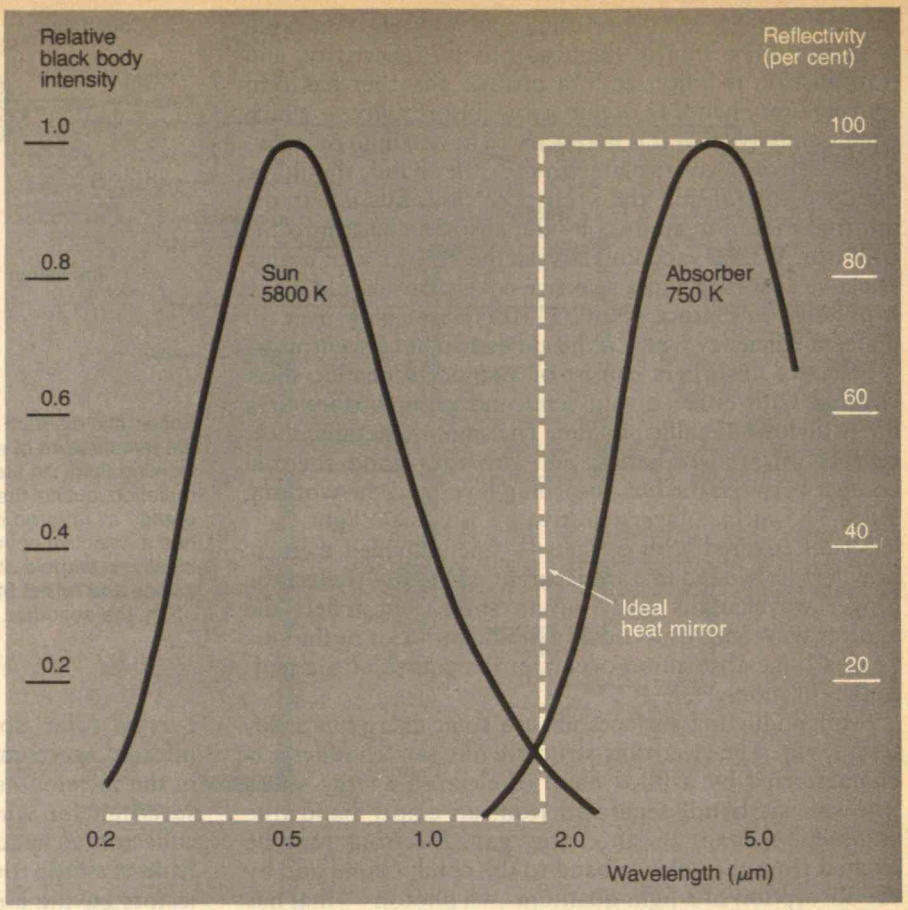
Schematic diagram of a solar-heat collector. Solar energy raises the temperature of an "absorber," and this heat is carried off by a working fluid. An ideal selective absorber captures all the solar radiation, but not the infrared radiation, so as not to emit its thermal energy as infrared radiation. The collector in the illustration also has a selective cover plate, a "heat mirror," whose purpose, ideally, is twofold: it should allow solar radiation to pass into the device and reflect back into the device the infrared radiation given off by the absorber.

The In_2O_3:Sn films provide a selective cover plate for terrestial solar-heat collectors that is equivalent in performance to the best selective absorbers. Moreover, selective cover plates remain cool, thus promising a longer life. $TiO_2/Ag/TiO_2$ films have been deposited on plastic, but thus far the best In_2O_3:Sn films must be deposited at too high a temperature for plastic substrates.

Cooling with Solar Heat

Refrigeration systems powered directly by solar energy are needed for the preservation of food and for air conditioning, especially in those climates where the sun is most intense. The problem is to achieve efficient cooling with the low-temperature heat available from a flat-plate collector.

A typical solar cooling system uses heat to desorb a gas from a liquid or solid sorbent. The gas is liquified in a condenser, which extracts heat that may be stored in hot water for domestic use. At night, the sorbent cools and reabsorbs or readsorbs the gas. Conventional systems use liquid lithium bromide as the sorbent and ammonia as the gas, but they require low condenser temperatures — eliminating hot water as a by-product — and higher sorbent temperatures than are readily available with a flat-plate collector. Water has the advantage of a much higher



The normalized spectrum of solar radiation is compared with that of a blackbody absorber in a solar-heat collector. The two are seen to have almost no overlap. It thus becomes advantageous to design selective surfaces with reflectivity approaching that shown by the dotted line: a selective cover plate would pass nearly all solar radiation and reflect nearly all absorber radiation; a selective absorber would capture nearly all solar radiation and reflect — hence not emit — nearly all infrared radiation.

heat of vaporation than ammonia.

D. I. Tchernev of Lincoln Laboratory has pointed out that zeolites (molecular-sieve aluminosilicates that adsorb over 30 weight per cent water) can be used. If 100 pounds of zeolite is cycled between 25° and 150°C (77° and 300°F), it will adsorb and desorb 13 pounds of water, which is equivalent to a compressor with a refrigeration capacity sufficient to produce 100 pounds of ice. With a solar day-night heating cycle, it will take one ton of zeolite (at about $150/ton) to produce one ton of air conditioning. Moreover, the system can also produce hot (140°F) water with little loss in efficiency, and the water adsorbed on the zeolite does not freeze. Although feasibility has been demonstrated in the laboratory, practical systems using zeolites have yet to be built.

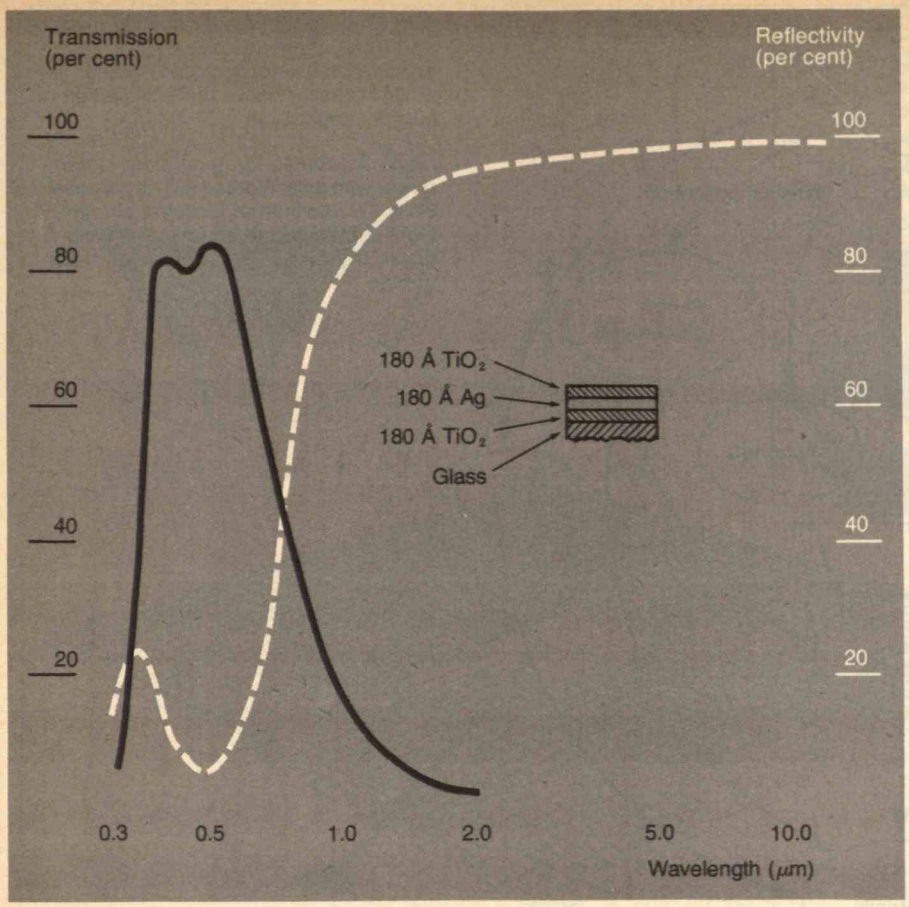
Increasing the Temperature of Solar Heat

An ideal flat-plate collector with presently available selective absorber and cover plate, and a vacuum between them, could have a theoretical efficiency of over 25 per cent for conversion of solar to thermal to electric energy. However, the conduction and convection losses of real terrestrial collectors currently prevent economic electric-power generation with unconcentrated sunlight. Concentration may be accomplished before or after solar energy has been converted. In the latter case, the energy is generally concentrated in an energy-storage medium. For example, the energy can be used to produce hydrogen from water by light-induced electrolysis, and the hydrogen can then be collected and concentrated in storage as gas in pressurized tanks, as solid hydrides, or as liquid fuel such as methanol or gasoline.

It may, however, be advantageous to concentrate the sunlight before it is converted. For thermal systems, two considerations favor this approach: the working temperature of the transfer fluid at the heat exchanger will be higher; and the concentration of sunlight from a large area may be more economical than the circulation of working fluid through an equivalent area of active thermal collector. On the other hand, concentration schemes that depend on focusing direct sunlight suffer from the loss of diffuse skylight, which may be 50 per cent or more of the total light available.

Sunlight may be concentrated by lenses or mirrors. At present, mirror-focusing systems are less expensive than lens systems to fabricate, install, and maintain; but both require steering mechanisms and accurately curved surfaces for following the motion of the sun.

Concentrators may be designed to respond only to the seasonal movement of the sun (a single axis system) or to track the sun throughout each day as well (double axis system). Cost considerations clearly favor the more modest concentration achievable with the former. Its heavy mirror assembly should be stationary and on the ground, to facilitate maintenance and avoid the need for a support structure. The lighter collector-conversion system moves along the single axis. The General Atomic Company's single-axis concentrator has achieved concentration factors of about 30; this compares with a concentration factor of 16,000 achieved in the Pyrenees installation with two-axis concentrators. With proper design of the collector, a 30-fold concentration should be adequate for practical generation of electric power with a heat engine. For less sophisticated applications, where only low-temperature heat is required, a flat-plate collector has three advantages over focusing collectors: it collects



The radiation-transmitting and radiation-reflecting properties of a heat mirror assembled as a layer of silver sandwiched between layers of titanium dioxide. The properties compare favorably with the ideal, shown by the dotted line on the facing page.

diffuse as well as direct sunlight; it can be mounted in a fixed position and remain untended; and its cost per unit area is lower.

Converting Solar into Electrical Energy

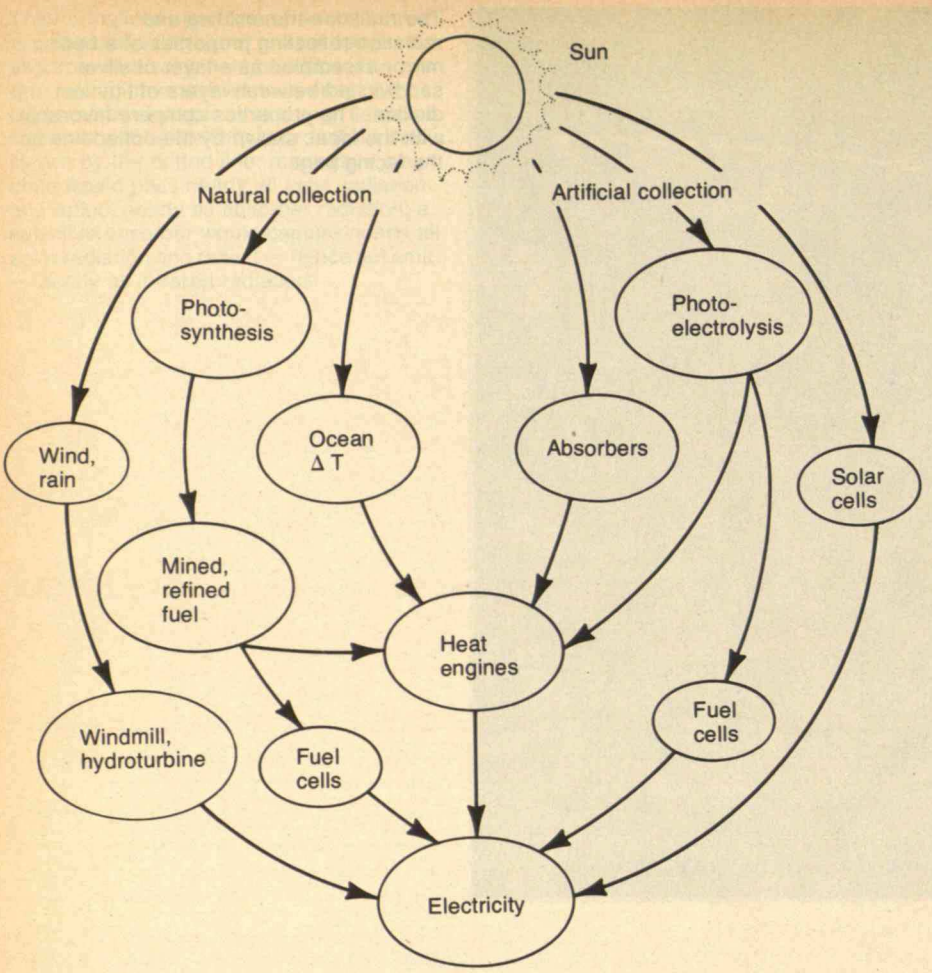
The figure on page 68 summarizes the alternatives for making electric power from solar energy. The use of a windmill or of hydropower to turn an electric generator is the oldest technique. Sunlight itself may be converted to electric power directly in a solar cell or indirectly, via solar-generated heat or fuel, in a heat engine or a fuel cell.

Direct conversion of solar energy to electric power utilizes, in every instance, two semiconductor phenomena: the creation of hole-electron pairs in a semiconductor by incident solar photons, and the separation of these holes and electrons at a discontinuity in electrochemical potential to create a voltage difference.

Practical semiconductors are plagued by incomplete separation of the light-generated hole-electron pairs unless single crystals of high quality are used. Electron-hole recombination at the crystal surface exposed to sunlight is also a problem. Thus, while theoretical efficiencies of about 25 per cent are possible, practical efficiencies are lower: single-crystal silicon and gallium-arsenide cells have been constructed with conversion efficiencies over 10 and 16 per cent, respectively. The cost of fabricating and interconnecting such cells has been prohibitive for terrestrial applications, but economic solar-cell fabrication, though difficult, may yet be realized by innovative research. Preliminary experiments indicate that polycrystalline silicon films having large-area grains (individual crystals) can be used to make silicon solar cells with efficiencies exceeding 10 per cent. Moreover, large-grain films have been made in the laboratory by techniques that appear amenable to economic mass production. Should solar cells offer an economically competitive method of generating electricity, their introduction to the market could introduce a major perturbation in the operation of the electric utilities.

Serious attention is being devoted to the indirect conversion of solar to electric power by driving conventional turbine equipment with solar-derived heat. High efficiency in such equipment requires high-temperature operation, and efficient conversion of solar energy to high-temperature heat requires focusing concentrators, which limits the usable solar energy to that available in direct sunlight. It follows that central power stations utilizing solar energy will have to be located in geographical areas where sunlight is plentiful, but this generally implies a scarcity of water. Cooling towers, required to dissipate heat from the steam condenser, consume large quantities of water: a 1,000-megawatt-electric power station might require 10,000 to 20,000 gallons per minute.

Philip O. Jarvinen of Lincoln Laboratory has proposed an alternate scheme for electric power generation using solar-heated air as the heat-transfer fluid and a gas-turbine generator. This plan, which is illustrated on page 69, not only avoids the need for water but also makes possible operation at much higher temperatures than those of conventional steam plants, which have an upper operating temperature limit of about 500°C imposed by the strength of the ceramic turbine blades. The simplest design suggests a solar-energy absorber located atop a tower. Two-axis reflectors collect sunlight over a large area and focus it on the absorber, from which heat is transferred to turbulently circulating air. The air delivers



Left: The alternatives for making electricity from solar energy. Some involve the exploitation of energy stored in water, wind, or life. Others involve the exploitation of sunlight itself.

Right: A scheme for generating electric power with solar-heated air, as proposed by Philip O. Jarvinen of Lincoln Laboratory. Light is reflected to an absorber atop a tower, from which hot air flows to a gas turbine.

heat to a gas-turbine power plant or to a thermal-storage system. The principal difficulty with this system will be the cost of the two-axis reflectors and the brightness of the absorber.

Other schemes for solar power plants have been advanced, the most celebrated of which is probably the "solar farm" proposal of Aden and Marjorie Meinel of the University of Arizona. The farm includes cylindrical concentrators and wavelength-selective absorbers to collect and transfer heat to a liquid that is circulated in a large array of pipes. In turn, the heated liquid would deliver the heat to a eutectic salt acting as a constant-temperature thermal-storage unit. In this scheme, the capital cost and the heat losses are probably prohibitively high.

Waste heat from any electric power plant can be used for heating or cooling residential buildings. This observation leads to the concept of a "solar-energy community," a complex of at least 20 — perhaps as many as 1,000 — living units serviced by a single solar system. The problem of high capital costs, which may inhibit the use of solar heating and cooling for individual houses, will be greatly alleviated in the case of a community, since much of the expense can be shared between the electric plant and the individual homes. Indeed, the first major impact of solar energy may well be associated with such systems.

Converting Solar into Chemical Energy

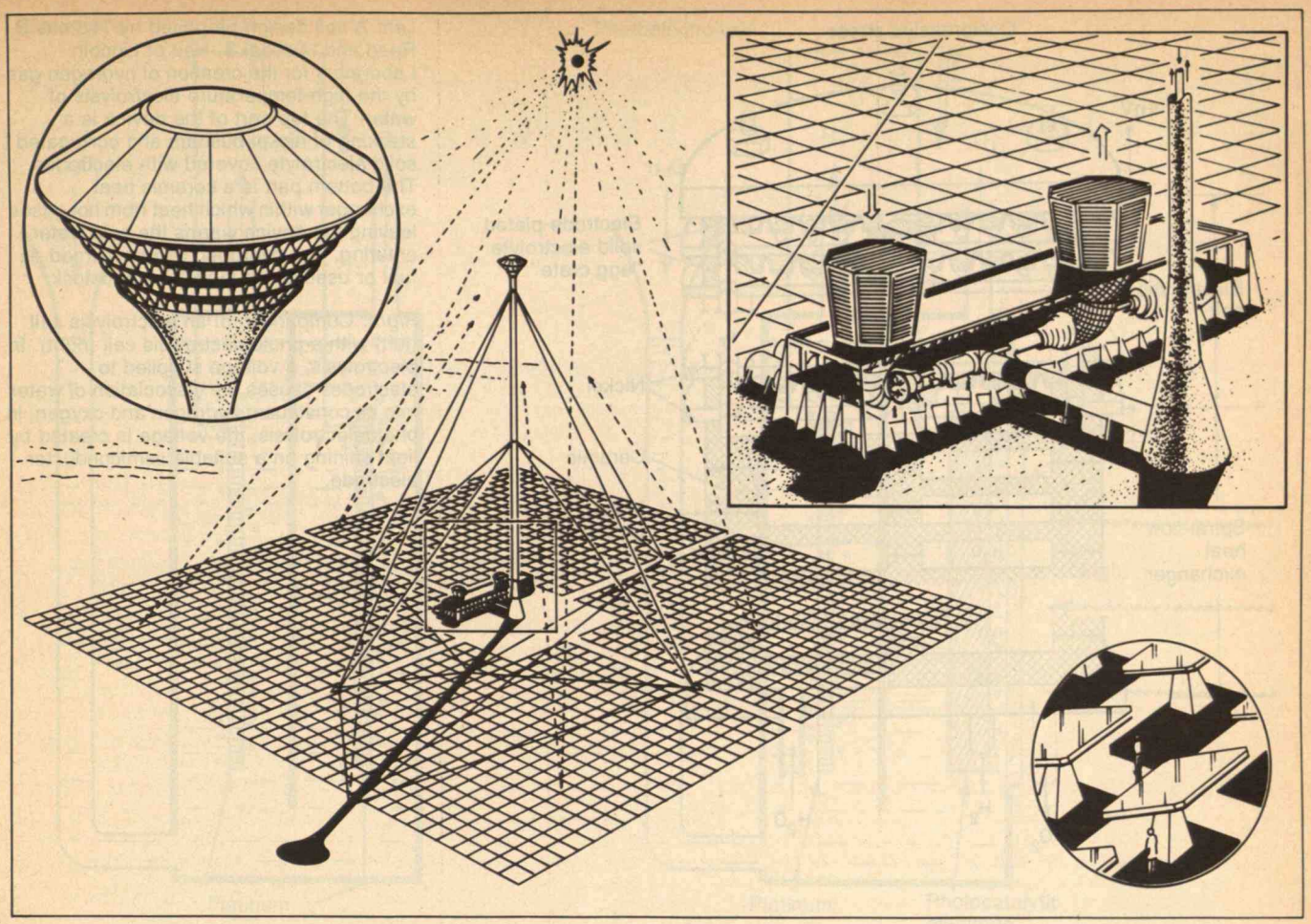
Stored energy that may be concentrated and conveniently transported has great advantages; these are dramatically illustrated by the fossil fuels, which are in fact solar energy accumulated and stored over centuries. Conversion of biomass from forest, agriculture, and urban wastes represents a short-term utilization of the same principle, but such energy can fill only a fraction of our present need for convenient fuels. Clearly, more efficient methods of converting solar energy to chemical energy are needed.

A compound may be separated into its constituent elements by heat (pyrolysis), by electrical energy (electrolysis), and by radiant energy (photolysis and photoelectrolysis). Some of this energy is stored, and can be released later by the recombination reaction. Water, for example, may be separated into hydrogen and oxygen: recombination produces 5,800 Btu per pound of water recreated, and water is a non-pollutant. The efficient production of hydrogen from water has become a major concern; and much has been written about the hydrogen economy.

The decomposition of water by pyrolysis, even with the aid of several intermediate chemical steps to reduce the required temperature from 4,000°C, presents many technical problems; electrolysis and photoelectrolysis are of more interest. At room temperature, electrolysis requires 1.23 volts; this requirement slowly decreases with rising temperature. The voltage is applied between two metallic electrodes separated by an electrolyte — a conductor of ions, but not of electrons. The electrolysis of water,

$$H_2O \rightarrow H_2 + \tfrac{1}{2}\, O_2$$

proceeds by electron transfer between the electrodes and the mobile ions in the electrolyte, gaseous hydrogen (H_2) appearing at the negative electrode and gaseous oxygen



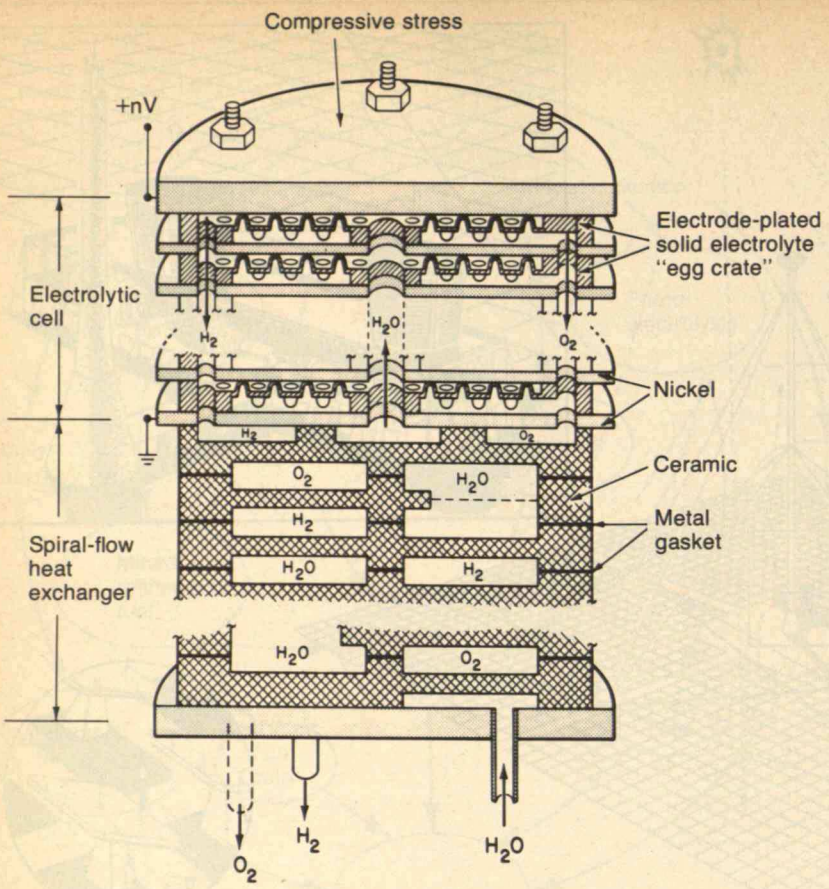
(O_2) at the positive electrode. Two approaches are possible: electrolysis with a liquid (aqueous) electrolyte or with a solid electrolyte.

Electrolysis of water from an aqueous electrolyte is restricted to low temperatures, for if high pressure is used to attain temperatures in excess of 100°C, the liquid electrolyte becomes too corrosive. At low temperatures, the kinetics of the reaction are slow, and considerable energy is lost in overvoltages. Catalytic electrodes, which are made of expensive metals like platinum or silver, must be introduced to speed up the reaction and lower the overvoltages. Even then, the low-temperature electrolysis of water is not at present competitive with the production of hydrogen from natural gas or petrochemicals.

The use of solid electrolytes is restricted to high temperatures because ions are not usually mobile in solids at low temperatures. Above 800°C, some solids, such as zirconia (ZrO_2) stabilized in the fluorite structure by substitution of some zirconium by calcium or yttrium, transport O^{2-} ions with sufficiently low resistivity so as to be practical. If a thin plate of such material has porous electrodes placed on either side, a voltage applied between the electrodes will make one side of the plate oxygen-rich, the other oxygen-poor. If, in addition, steam is passed over the oxygen-poor surface, the oxygen of a gaseous H_2O molecule will enter an O^{2-} vacancy in the solid and pick up two electrons from the electrode, leaving gaseous H_2 behind. At the oxygen-rich surface, two electrons are given up by each of two neighboring O^{2-} ions, and gaseous O_2 leaves the surface. Above 800°C the kinetics of these reactions are fast, nearly eliminating overvoltages, and the principal efficiency loss is due to the resistance of the solid electrolyte to O^{2-}-ion motion. This loss may be minimized by fabricating the electrolyte as thin ceramic membranes.

The low voltage and high heat applied to a solid electrolyte at high temperatures reduce the electrical energy consumed per unit weight of hydrogen. However, efficient utilization of heat requires good heat flow into the cell, good insulation, and an exchange of heat between the hot gases flowing out from the cell and the colder water flowing in. Moreover, a thermal-expansion mismatch between the electrodes and the ceramic electrolyte must not cause the electrolyte to crack. These multiple requirements present a design challenge to the engineer, and Thomas B. Reed and Michael S. Hsu of Lincoln Laboratory have suggested a promising solution: alternate stacking of nickel bus-bar disks and corrugated, electrode-coated electrolyte membranes, followed by a ceramic-disk counterflow heat exchanger, all held together by compressive forces (*see the illustration on page 70*). The high-temperature heat could be supplied by a variety of sources, including focused solar energy; the electric power could be supplied by a solar cell or by burning a fraction of the product hydrogen in a low-temperature fuel cell. A fuel cell is the inverse of an electrolytic cell: gaseous hydrogen and oxygen are fed to separate, porous electrodes, and chemical interactions at the interfaces among gas, electrodes, and electrolyte produce a voltage between the electrodes.

The energy required (approximately 6.8 electron-volts) to decompose water directly into its constituent gases by photolysis is in the far ultraviolet, the region of the solar spectrum that is filtered out by the upper atmosphere. It is



Left: A cell design proposed by Thomas B. Reed and Michael S. Hsu of Lincoln Laboratory for the creation of hydrogen gas by the high-temperature electrolysis of water. The top part of the device is a stacking of nickel busbars and corrugated solid electrolyte covered with electrodes. The bottom part is a ceramic heat exchanger within which heat from hot gases leaving the device warms the cold water entering. The hydrogen can be burned as fuel or used as an industrial feedstock.

Right: Comparison of an electrolysis cell (left) with a photoelectrolysis cell (right). In electrolysis, a voltage supplied to electrodes causes the dissociation of water into its constituent hydrogen and oxygen; in photoelectrolysis, the voltage is created by light shining on a suitable semiconductor electrode.

for this reason that terrestrial water is evaporated — not dissociated — by solar radiation. However, a major fraction of the solar radiation has energy in excess of 1.23 electron-volts. Therefore, a suitable catalytic electrode could promote the dissociation of water by photoelectrolysis.

The figure on the opposite page compares schematically a conventional electrolysis cell and a photoelectrolysis cell. In the photoelectrolysis cell, the light shining on a semiconductor electrode supplies the voltage for electrolysis. Electrons are transferred from the surface of one electrode to the liquid to produce hydrogen via the reaction

$$2H^+ + 2e^- \rightarrow H_2$$

or

$$2H_2O + 2e^- \rightarrow 2OH^- + H_2.$$

At the semiconductor electrode, electrons recombine with holes, and oxygen is produced via the reaction

$$H_2O - 2e^- \rightarrow 1/2\ O_2 + 2H^+$$

or

$$2OH^- - 2e^- \rightarrow H_2O + 1/2\ O_2.$$

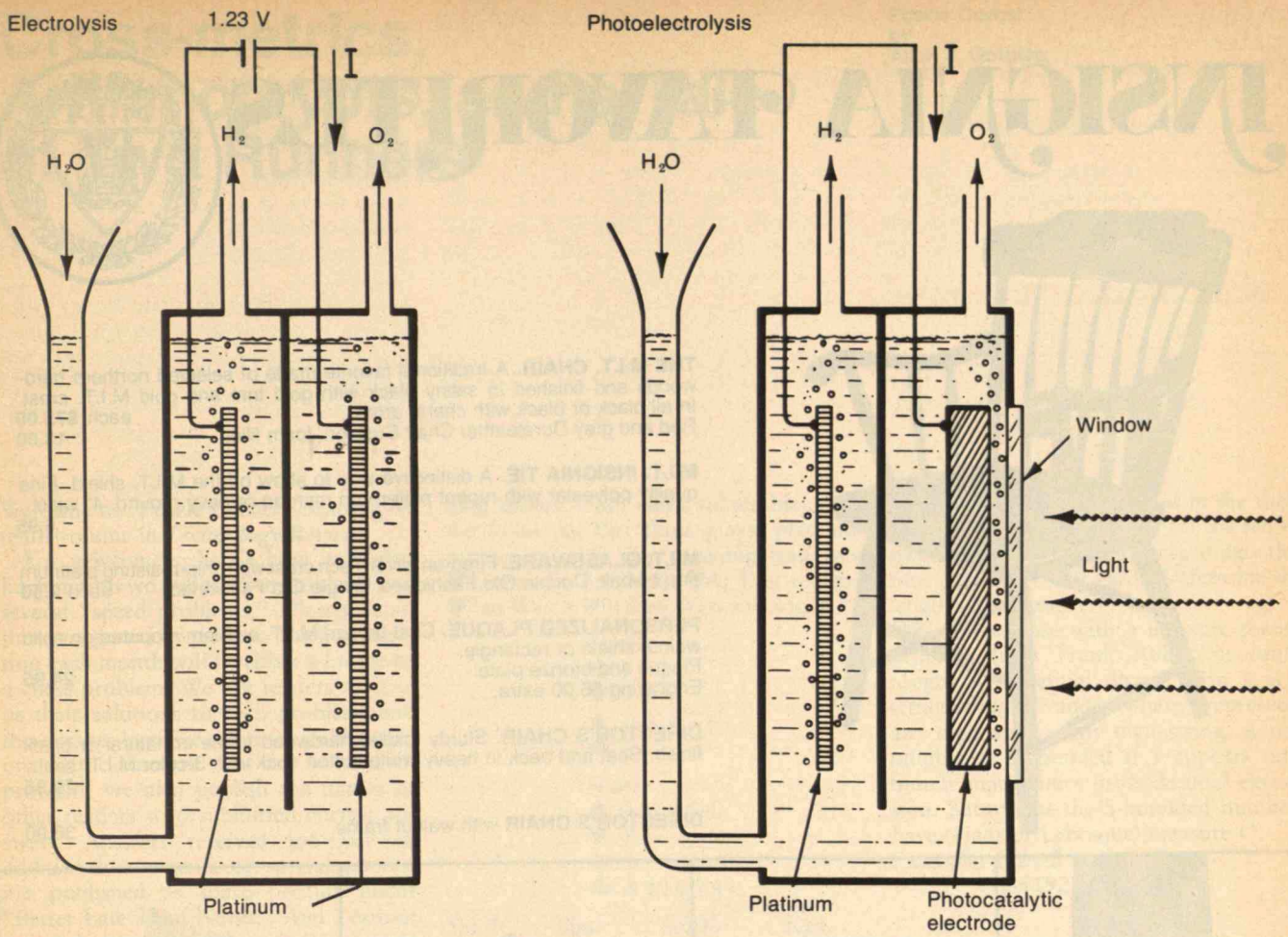
The essential principle of photoelectrolysis has been demonstrated to be efficient and to operate well with polycrystalline-film electrodes. The electrical properties required for the semiconductor, however, are stringent. Since the cost of preparing the materials is minimal and the need for hydrogen — and synthetic fuels — is great, there is ample motivation to search for a semiconductor that more nearly satisfies these requirements than the materials used at present.

The Problem of Storage

Diurnal, seasonal, and intermittent (weather-induced) changes in the solar energy available at any given place and time make energy storage a necessary adjunct to terrestrial solar-energy systems. It is for this reason that Peter E. Glaser of Arthur D. Little, Inc., has proposed that a satellite solar-power station be placed in synchronous orbit above the earth's atmosphere so as to receive solar energy continuously. The satellite would use huge mirror concentrators and photovoltaic cells to drive a microwave antenna one kilometer in diameter beaming electromagnetic energy to an earth-based receiving station. This bold scheme suffers from the high cost of solar cells and of establishing in space a working system of sufficient reliability; questions also remain about the efficiency and management of the transmission system. Therefore, the storage problem associated with a terrestrial system is not easily avoided.

Three storage options are available for a system that transforms solar to thermal to electrical energy: storage of thermal energy, storage of electromagnetic energy, or storage of chemical or mechanical energy if these last are efficiently interchanged with electrical energy. Photovoltaic systems have only the last two options. A heating system has only the first.

Thermal energy may be stored either as sensible heat or as latent heat. Latent heat is released when a material changes phase, as water from gas to liquid. Large heat capacities are associated with phase changes in salts; but this storage is available only at the fixed temperature of the phase transition, and materials having a transition at interesting temperatures tend to be corrosive at those temperatures. The storage of sensible heat allows flexibil-



ity as to temperature; water and most rocks have large heat capacities. Tanks containing a mixture of water and steam under pressure can store sensible heat in water at costs in excess of $50 per kilowatt-hour of installed capacity. Underground siting could reduce this cost to about $15 per kilowatt-hour. If air is the heat-transfer medium, storage of sensible heat in a pebble bed or rock pile can be achieved at similarly low cost ($10 to $50 per kilowatt-hour).

Electrical energy may be stored directly in condenser banks or in superconducting solenoids. However, it is generally more practical to convert the electrical energy to chemical or mechanical energy. Lead-acid batteries store chemical energy and cost $10 to $50 per kilowatt-hour of capacity; although they store energy well, they store power poorly because they have appreciable internal resistances and degrade their internal structures on rapid discharge. Flywheels can be used to store mechanical kinetic energy; they have high storage density — approaching a kilowatt-hour per pound — and peak-power outputs a million times greater than those available from batteries or fuel cells. However, they provide only short-term storage (less than one week for moderate sizes) and are relatively expensive. Moreover, their use implies conversion of solar to mechanical energy. Losses associated with this conversion may be serious. The simplest method of storing mechanical energy is in pumped water; the potential energy of a body of water at a high elevation can be retrieved by releasing the water through a turbine. This system is practical in locations where land costs are not prohibitive.

Toward a Solar Future

This article has summarized some novel ideas that must be developed if solar energy is to make a major contribution to our energy economy. No attempt has been made to estimate the relative economic merits of the many solar-energy conversion systems that have been described or to estimate the time required for each to affect the energy economy. But it is clear that the number of our future engineering options depends on how many collection, conversion, and storage schemes can in fact be developed to the point of economic viability. Since industry cannot afford to gamble on long-range, high-risk research, the development of the advanced technology needed will have to be accomplished primarily with government support. It is a capital-intensive enterprise, which is why it has not been developed already by the many nations poor in energy but rich in sunshine. How rapidly and at what price we achieve the widespread utilization of solar energy will depend upon the wills of nations rich in capital, and upon the wisdom with which their governments allocate funding among the many opportunities that await study and exploitation.

John B. Goodenough received an A.B. in mathematics from Yale University in 1943, then served as a meteorologist in the U.S.A.A.F. from 1942-48, and received a Ph.D. in physics from the University of Chicago in 1952. From 1952-76 he worked at M.I.T.'s Lincoln Laboratory, building bridges between electrical engineering and chemistry for the design of new electronic materials — especially materials for alternate technologies of energy conversion and storage. On August 1, 1976, he assumed the Chair of Inorganic Chemistry at Oxford University, England.

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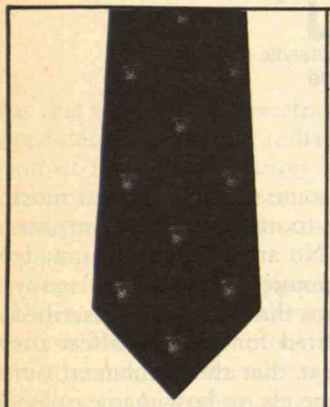

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Cross-metrics, Arithmocrypts, and a Tale of Two Runners

Puzzle Corner
by
Allan J. Gottlieb

Welcome to "Puzzle Corner," starting its tenth volume in *Technology Review*!

For newcomers, here's how it works: Each month we publish five problems and several "speed problems," selected from those suggested by readers. The first selection each month will be either a bridge or a chess problem. We ask readers to send us their solutions to each problem, and three issues later we select for publication one of the answers — if any — to each problem; we also publish the names of other readers who submitted correct answers. Answers received too late or additional comments of special interest are published as space permits under "Better Late Than Never." And I cannot respond to readers' queries except through the column itself.

Please note especially this month's "Better Late Than Never" section, because a problem published in June, 1975, is modified and reissued in it. The solution to the modified problem will appear in the February, 1977, issue, together with those of the new problems presented in this column.

Please note also that the fifth problem presented in June, 1976, was incorrectly stated. It should read:

JUN 5 A man walking near a lake with a precipitous shoreline sees a girl struggling in the water. He can run twice as fast as *he* can swim. At what point should he leave the shore to reach her in the shortest possible time? The spatial relationships are: the man is 100 feet from the water; the distance between the man and girl, parallel to the shore line, is 100 feet; *and the girl is 100 feet from the shore*. Ground rule: no calculus. (The girl drowns while the man is calculating the best course, but that's irrelevant to the problem.)

Problems

Here are five new problems for this month. Solutions which reach me by December 1 will be in time for possible use in the February issue.

O/N 1 We begin with a bridge problem from *D-Notes*, a publication of the Charles Stark Draper Laboratories; *D-Notes*' bridge department is run by Ben Dores. Given the two hands and the bidding shown (both sides vulnerable), and the following first three plays, plan the balance of play. The opening lead was ♥3, won by East with ♥A; East returns ♥7 to West's ♥9; then West shifts to ♦3.

North
♠ J 7 3 2
♥ 6 2
♦ A K 8 7 6
♣ J 3

South
♠ A K 6 5 4
♥ 8 5
♦ 2
♣ A 10 6 5 4

South	*West*	*North*	*East*
1 club	—	1 diamond	1 heart
1 heart	3 hearts	3 spades	—
4 hearts	—	—	—

O/N 2 Magne Wathne noticed that 9/1 = 9, 98/12 = 8.166 . . ., and 987/123 = 8.024 . . . He then found patterns for the numerator and denominator which begin with the three given and result in fractions which approach 8. What are those patterns? Clearly {9, 98, 987, 8, 8, 8, . . .} and {1, 12, 123, 1, 1, 1, . . .} work, but we want a true pattern.

O/N 3 R. Robinson Rowe has submitted a cross-metric for us to tackle:

$$\begin{array}{ccccc} \text{HHE} & \times & \text{TEN} & = & \text{AUITM} \\ - & & \times & & - \\ \text{EALI} & - & \text{HIE} & = & \text{ETAM} \\ = & & = & & \text{H} \\ \text{CIIE} & + & \text{ATMAM} & = & \text{AHMLI} \end{array}$$

He explains that the cross-metric consists of nine literally-coded numbers related by six arithmetic operations, three being horizontal and three vertical. As coded, the numbers are words only by accident, but the code — in digital order — is literate and may be cited as the solution.

O/N 4 An interesting puzzle from Charles Piper: A offers to run three times around a course while B runs twice around, but A gets only 150 yards of his third round finished when B wins. He then offers to run four times around for B's thrice and now quickens his pace in the ratio of 4:3. B also quickens his in the ratio of 9:8 but in the second round falls back to his original pace of the first race and in the third round goes only nine yards for the ten he went in the first race, and accordingly this time A wins by 180 yards. Determine the length of the course.

O/N 5 We close with a measure theory problem from Frank Rubin; it looks tough: A sentential digital form S is a string of digits ? and ~ where ? represents any digit and ~ any digit string. A real number is S-bounded if S appears only finitely many times in its decimal expansion. Show that the S-bounded numbers have (Haar or Lebesque) measure O.

Example: 1?2~3 appears in

.351927536802 . . .
1?2~3

Speed Department

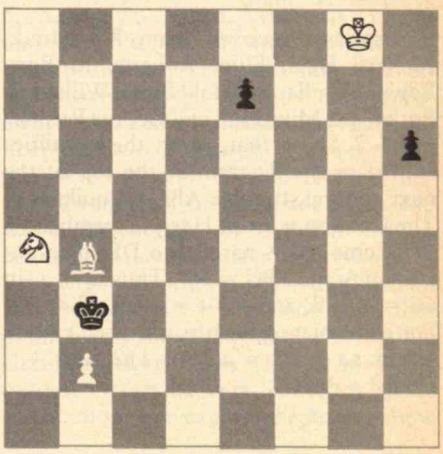
O/N SD 1 We have a novelty this month — a speed chess problem from Jeff Kenton; Mr. Kenton believes the problem originates with Sam Lloyd: Find a position in which a lone king is mated in the middle of the board by two rooks and a knight.

O/N SD 2 Our Lilliputian, Ted Mita, asks: If you were trapped under a giant phonograph record which way would you crawl to get out?

Solutions

The following are solutions to problems published in May:

MAY 1 Given the following, White is to play and win.



Basically, the responses fell into three camps: B–B3, B–Q2, and hopeless. I think B–Q2 is refuted by K x N, B x P, P–K4! The B–Q2 camp expected K–N6. The "hopeless" camp, which noticed P–K4!, missed P–N3 mate in the following solution from George Mortimer:

White can win in one of two ways:
— Capture the two black pawns while losing only one pawn and checkmate with K, B, and N vs. K.
— Queen his lone pawn.
From the given position, White cannot prevent loss of either N or B; therefore, the first option above is not under White's control. He must go for the second option. Since he must wage battle across the span of the board, he needs a piece which can span the board at a single move—the B. He must save it. Therefore, play follows:

	White	*Black*
1.	B — B3	K x N

White's move protects the P and the B by each other and prevents advance of Black's KP. Black now has only a K and RP to play with. Black could make many other moves, but if he did not take the N now it would be safely gone on White's second move and the game would no longer be a contest.

2.	K — B7	. . .

White's intention is to bring his K into position to guard his P and release his B to chase Black's Rs, since the White K cannot catch Black's RP. Black can stop this by playing K — N6, but then White is given his Black's RP and Black has nothing left to play with. Therefore,

2.	. . .	P — R4
3.	K — K6	P — R5
4.	K — Q5	P — R6

If black plays K — N6 in the fourth move instead, K — K4 in the fifth puts White's K even with Black's RP and he catches it as it queens. White's win is then routine.

5.	K — B4	. . .

Black's K is now immobilized. Perhaps he overlooks this fact in his mad race to obtain a queen. If so, then play continues:

5.	. . .	P — R7
6.	B — N4	P — R8 (queens)
7.	P — N3 mate	

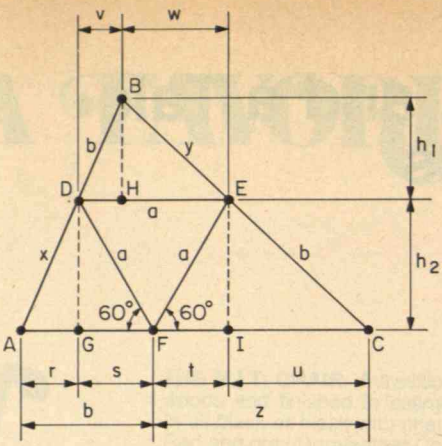
Responses received from Bill Munk, Richard Hess, Elliot Roberts, R. Bart, Edward Gaillard, Gerald Blum, William J. Butler, Jr., Mike Hill, and George Farnell.

MAY 2 Show that, given the equalities shown in the diagram at the top of the next column, triangle ABC is equilateral. The solution is from Harry Zaremba.

Assume AC is parallel to DE; then angles DFA and EFC = 60°. Thus $h_2 = a \sin 60 = \sqrt{3}a/2$, and $s = t = a \cos 60 = a/2$. For convenience, let $b = na$. Then $r = na - e = na - a/2 = a(2n - 1)/2$, and

$x = (h_2^2 + r^2)^{\frac{1}{2}}$, or

$$x = a(n^2 - n + 1)^{\frac{1}{2}}. \quad (1)$$



Similarly, $u = (b^2 - h_2^2)^{\frac{1}{2}}$, or $u = a(4n^2 - 3)^{\frac{1}{2}}/2$. Therefore,

$$z = t + u = a/2 + a(4n^2 - 3)^{\frac{1}{2}}/2. \quad (2)$$

From similar triangles ADG and DBH, $h_1/na = h_2/x$, or $h_1 = \sqrt{3}na/2(n^2 - n + 1)^{\frac{1}{2}}$. Also, from similar triangles BHE and EIC, $y/h_1 = na/h_2$, or

$$y = n^2a/(n^2 - n + 1)^{\frac{1}{2}}. \quad (3)$$

In triangle DBH, $v = [(na)^2 - h_1^2]^{\frac{1}{2}} = na(2n - 1)/2(n^2 - n + 1)^{\frac{1}{2}}$, and in triangle BHE, $w = (y^2 - h_1^2)^{\frac{1}{2}} = na(4n^2 - 3)^{\frac{1}{2}}/2(n^2 - n + 1)^{\frac{1}{2}}$. Hence $a = v + w$, or $a = [na(2n - 1) + na(4n^2 - 3)^{\frac{1}{2}}]/2(n^2 - n + 1)^{\frac{1}{2}}$. After removing radicals and simplifying,

$$3n^6 - 4n^5 + 3n^4 + n^3 - 4n^2 + 2n - 1 = 0 \quad (4)$$

The rational solution of equation (4) is $n = 1$, making $b = na = a$. Substituting $n = 1$ into expressions (1), (2), and (3) results in $x = z = y = a$. Therefore, $b + x = b + y = b + z = 2a$, proving that triangle ABC is equilateral.

Also solved by R. Bart, Burnham H. Dodge, Mary Lindenberg, Jo Anne Levatin, Richard I. Hess, M. Fuerst, and R. Robinson Rowe.

MAY 3 A cryptarithmetic problem: which digit does each letter represent:

A BOY asked a GIRL to become his wife
When each one was in the prime of their life.
If they simply add LOVE, there is but one hope . . .
The result of it all is that they ELOPE.

The poem represents the mathematics problem:

$$\begin{array}{r} \text{BOY} \\ \text{GIRL} \\ +\ \text{LOVE} \\ \hline \text{ELOPE} \end{array}$$

with BOY and GIRL being primes.

The following is from William C. Schumacher, who says he was "fascinated to see the use of prime numbers as clues. For a simple appearing problem it required more deductions and more kinds of deductions than most cryptarithmetic problems (why not call them arithmocrypts?) that may look more complex on the surface." Here is Mr. Schumacher's solution:

a) B, G, L, and E, as the initial letters of the four words, are not zero.
b) The sum of three different digits (as B + I + O, or O + R + V, or Y + L + E) cannot exceed 24, and with a carry from another such column of three cannot exceed 26.
c) The sum of two different digits cannot exceed 17, and with a carry from another column of up to three different digits cannot exceed 19.
d) Therefore, E equals 1. (Representing the carry from the thousands column.)
e) Since "BOY" and "GIRL" are both primes, Y and L are members of the set (1, 3, 7, 9). But 1 is no longer available; therefore, they are members of the set (3, 7, 9).
f) From the units column, Y + L + E = E, or Y + L + E = E + 10. Therefore, Y and L are each other's complements modulo 10. But as neither of them can be 1 (because E = 1), so neither of them can be 9. Therefore Y and L are 3 and 7 (not necessarily respectively), so, while it is too early to specify which is which, no other letters can be 3 or 7.
g) From the hundreds column, B + I + O = O, or B + I + O = O ± 10, or B + I + O = O ± 20. As B and I cannot both be zero, the first possibility is ruled out; and as B ± I + (tens carry) cannot exceed 19, the third possibility is also ruled out. Therefore, B and I must be each other's complements modulo 10 if there is no tens carry, or modulo 9 or 8 if there is a tens carry of 1 or 2, respectively.
h) The thousands column G + L + (hundreds carry) = EL (or L + 10) requires that G be 8 or 9. But since B + I + O = O + 10, the hundreds carry must be 1, and G must be 9.
i) As the only uncommitted odd digit is 5, and the units carry is 1, the tens column O + R + V + (units carry) = P requires that one of these letters be 5, and the other three be even. In other words, O, R, V, and P are members of the set (O, 2, 4, 5, 6, 8) with the stipulation that one of them must be 5.
j) Examining the possible groupings of values to comply with the tens column addition O + R + V + 1 = P, or O + R + V + 1 = P + 10, it is found that all except one of such groupings lead to the sum P ± 10. The one that does not is O + 2 + 5 + 1 = 8.
k) If the tens column produces a carry of 1, B and I would have to be each other's complements modulo 9, which is impossible if they are limited (as they now are) to even digits. Therefore, the tens column must comprise digits 0, 2, and 5 as addends, 1 as incoming carry, and 8 as sum. With 8 no longer available, B and I must be 4 and 6, not necessarily respectively; but no other letters can be 4 or 6.
l) At this point, we are reduced to

B = 4 or 6
O = 0, 2, or 5
Y = 3 or 7
G = 9
I = 4 or 6
R = 0, 2, or 5
L = 3 or 7

Independently, each of these words could be assigned any of 12 values, but since the use of a digit in either denies it to the other, only 24 permissible conbinations exist. Moreover, by inspection five values in each group of twelve are multiples of 3 and two other values in each group are multiples of 7.

m) The remaining permissible values are

BOY = 403, 407, 457, 607, or 653
GIRL = 9403, 9407, 9427, 9607, or 9623

n) Of these, 403, 407, 9407, 9427, and 9607 are nonprimes. The only combination of primes with nonduplicating digits is 457/9623.

o) After assigning these digits to the appropriate letters, only V = O is left.

p) Checking the arithmetic, 457 + 9623 + 3501 = 13,581. Everything fits.

Also solved by Don Garvett, Erik Anderson, Jeffrey A. Miller, Charles Polay, Richard A. Bator, James D. Abbott, Mark Marinch, Paul Benefiel, Roger A. Whitman, Sam Wheatman, John D. Rothschild, Gerald Blum, William J. Butler, Jr., Harry Zaremba, R. Bart, Richard I. Hess, and the proposer, Avi Ornstein.

MAY 4 A four-legged stool stands on an uneven floor. There are no sudden steps, but the floor is wavy, with bumps and hollows. The stool will stand, of course, with three legs touching the floor. Is it always possible to turn and/or move the stool so that it stands firmly with *all four* legs touching the floor?

One thing must be made clear: the legs of the stool are of equal length and symmetrically placed. If the legs may be of unequal length, choose a stool with three very long legs and one very short; then if the floor is not too wavy the stool cannot have all legs touching. This analysis is from Richard I. Hess. With the equal-length assumption, the answer is yes. The following is from R. Robinson Rowe:

In a random setting of the stool, let the three legs touching the floor be A, B, and C, and let leg D be "airborne." Let the ground plane be one parallel to the one through the contact points of legs A, B, and C, below that plane and above the floor under leg D. Then, with respect to this ground plane, legs A, B, and C are at high points and leg D is above a low point. In any self-respecting stool, the four legs are in symmetry such that their feet may be inscribed in a circle. Project that circle on the undulating floor and elevations along the perimeter, if developed, would graph as an irregular sinuous curve — partly above and partly below the gound plane. That curve has no "steps." Now rotate the stool about its vertical axis, keeping legs A, B, and C in contact with the floor. If rotation reached 90°, leg D would be at a high point and leg C *over* the established low point — and no longer in contact. There being no sudden steps, at some intermediate point, D would have made contact and C would still be in contact. Hence it is always possible to *turn* the stool to a stable setting. I use this strategem often. To replace a bulb in a ceiling electrolier, I use a kitchen stool and for safety rotate it until it is steady.

Also solved by R. Bart, Gerald Blum, and William J. Butler, Jr.

MAY 5 A square number is one which can be represented by an array of points in the form of a square. Similarly, a triangular number is one which can be represented by an array of points in the form of an equilateral triangle. The square numbers are 1, 4, 9, 16, 25, 36, . . . The triangular numbers are 1, 3, 6, 10, 15, 21, 28, 36, . . . The first number after 1 which is both a square and a triangular number is 36; what is the next number which is both square and triangular?

Several readers gave detailed analyses for this problem — far beyond what was called for. In the interest of space economy, I am presenting a somewhat terse account from Winslow H. Hartford: Since triangular numbers are represented by $n(n + 1)/2$ and squares by m^2, we require a solution of the equation $n^2 + n = 2m^2$. Solutions exist when $n = 1$, $m = 1$ and $n = 8$, $m = 6$. However, there are two cases:

— $n + 1 = 2k^2$, $n = l^2$ ($m^2 = k^2l^2$) where $l^2 + 1 = 2k^2$ or $2k^2 - l^2 = 1$.

— $n + 1 = l^2$, $n = 2k^2$, where $2k^2 + 1 = l^2$ or $2k^2 - l^2 = -1$ ($2k^2 - l^2 = \pm 1$).

It may be shown that solutions exist where

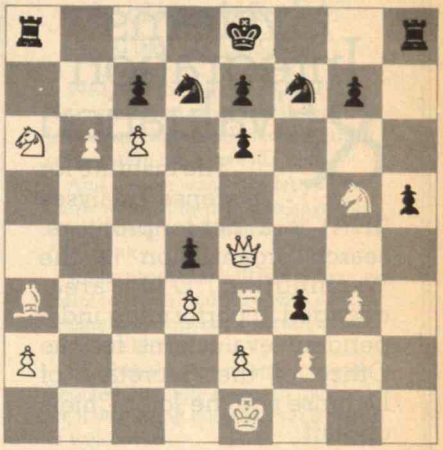
	k	l	n	n + 1	m	$m^2 = \Delta$
(2)	0	1	0	1	0	0
(1)	1	1	1	1	1	1
(2)	2	3	8	9	6	36
(*)	5	7	49	50	35	*1225*
(2)	12	17	288	289	204	41616
(1)	29	41	1681	1682	1189	1413721
(2)	70	99	9800	9801	6930	48024900

The asterisk marks the requested solution. It is also obvious that l/k forms a Fibonacci-like series: 1/0, 1/1, 3/2, 7/5, 17/12, 41/29, 99/70, 239/169 . . . where $l_{n+1} = l_n + 2k_n$ and $k_{n+1} = l_n + k_n$, and $\lim_{n\to\infty} l/k = \sqrt{2}$.

Also solved by Bob Schmidt, Vern Reisenleiter, John E. Prussing, Carl F. Muckenhoupt, Frank Carbin, John Colton, R. Robinson Rowe, Johan Novick, Naomi Markovitz, R. E. Crandall, Charles Rozier, Nadin Godrej, Sanford Libman, Raymond Gaillard, Emmet Duffy, Mark Marinch, Dick Boyd, James Fiasconaro, George Mortimer, James Cawse, Gerald Blum, Robert Bart, Erik Anderson, Thomas Jenkins, Roger Whitman, Paul Benefiel, Jeffrey Miller, Richard Hess, Harry Zaremba, Sam Whentman, Avi Ornstein, Mary Lindenberg, William J. Butler, Jr., and the proposer, Kier Finlayson.

Better Late Than Never

1975 JUN 1 Harry Nelson, the proposer, informs me that the White pawn at KR5 should be Black. He claims the problem is now possible; I can come close, but . . . The correct problem is: White to move and mate in two.



Thus the problem is reinstated, and a solution will be given in February.

1975 O/N 1 A rebuttal from William J. Butler, Jr.: I originally sent in a table of combinations for this problem, and this table was published in February, 1976. The June, 1976, issue contains another analysis which disagrees with this table. I believe there are two flaws in the June analysis which accounts for the difference. First, in calculating probabilities either all possible outcomes must be equally likely or else the outcomes must be proportionately weighted. As soon as a player makes a voluntary discard he alters random probability. For example if West started with no spades (three diamonds), eight clubs, and two hearts, he would deliberately avoid discarding a heart and thus alter random results. If West discarded randomly on the spade tricks and was lucky enough not to throw away a heart, then the analysis given in the June issue would be proper. The second flaw in the June analysis is the conclusion that South learns something about the original club-heart distribution while he plays the spades. In fact he only learns the spade distribution. For example, consider these

three-distributional hands for West.

one spade	one spade
no hearts	one heart
three diamonds	three diamonds
nine clubs	eight clubs

one spade
two hearts
three diamonds
seven clubs

When South plays the second and third rounds of spades, West will discard clubs for all three possibilities (i.e., South has learned no more additional information other than West started with a singleton spade). Similarly, East will be following suit each time. When it is time for the critical heart play, South will know how many combined cards each has, but he will not have any more information except that in the original table.

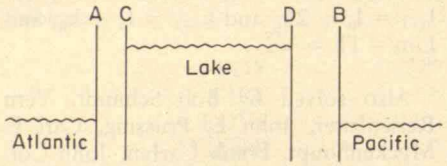
1975 DEC 4 R. Brent *et al.* have a related paper in *SIAM Journal of Applied Mathematics*, January, 1976.

1976 JAN 5 Jerry Goldman points out that in reduction 2 we can assume only that A is upper triangular, but this is sufficient for the rest of the proof.

1976 FEB 2 Eric Jamin has responded, and M. Fuerst points out that it is not clear how to determine the number of closed routes over a complete heptagon.

1976 FEB 3 Carl Greever has responded.

1976 FEB 4 Eric Jamin has responded, and Earl Rogers has explained why we received several different answers: Garman's solution "isolated" the lake — that is, considered the locks as part of the oceans and only looked at the flow through the lake gates. Blum's solution considered the locks as part of the lake and, therefore, looked at the flow out of the ocean gates. If done correctly, either method should give the same answer. But Jarman made an error by stating that it takes the same amount of water to fill each lock. He correctly concluded that the ship displacements (Vs) offset each other, but it does *not* take the same amount of water to fill each lock. If V_L is the volume of the locks ($V_{AC} = V_{DB}$), V_s the volume displaced by a ship, and + indicates flow out of the lake (− indicates flow into the lake), when the Atlantic lock is filled it only takes $V_L - V_s$ water, since the ship is in the lock. When the Pacific lock is filled, it takes a full V_L since it is empty of ships.



Thus it takes $V_L - V_s + V_L$ or $2V_L - V_s$ to fill the locks, which is Blum's answer. Earl Rogers has shown both solutions in detail, but space does not permit publication; interested readers should write to the editors for a copy.

1976 FEB 5 Eric Jamin has responded, and Robert Pogoff points out that our published version of his solution should indicate *three* solutions to 1 × 1 × 3 problem and two *views* of *one* solution to the 1 × 2 × 3 problem.

1976 M/A 1 Joseph G. Haubrich and William J. Butler have responded.

M/A 2 Joseph Haubrich, Eric Jamin, Henry Barten, Winslow H. Hartford, Bob Kimble, Dennis White, and Harold M. Wilensky have responded.

M/A 3 Winslow H. Hartford and Joseph Haubrich have responded. John E. Prussing points out that a harder problem is to find a tunnel so that a trip between two points takes the minimum possible time. The answer is a hypocycloid; he proves this in an article in the *American Journal of Physics* (Vol. 44, No. 3, p. 304).

M/A 5 Joseph Haubrich, Eric Jamin, Bob Schmidt, Winslow Hartford, Greg Schaffer, and Sam Jacobs have responded. Thomas Jenkins points out that the solution for 14 should be 4!/4 + 4 + 4.

M/A SD 1 Two interesting responses have been received. The first is from Ken Darrow, who writes that, given the assumptions, with only one male born per family, the number of families in each generation would remain constant (as the proposer states). However, one can postulate a set of conditions satisfying all of the assumptions which produces extra females; he calls his solution "The Old Maid Theory":

The proposer's solution is based on the implicit assumption that "each" male has a 50-per-cent probability of producing male offspring. All we can tell from statistics is that the "average" male's offspring are 50:50 boys to girls. Suppose that this average contains some males with a higher probability of having boys and some with a lower probability. For example, if 50 per cent of the population produced offspring at 50:50, 25 per cent at 60:40, and 25 per cent at 40:60, the average would still be 50:50; but under the "one-boy" law more girls (in the ratio of 51/49) would be born (*see table at the top of the next page*).

One could further object to the proposer's solution on the grounds that the observed birth rate in the U.S. is not 50:50 but actually 51.3:48.7 boys to girls. Using his logic, population would actually decrease.

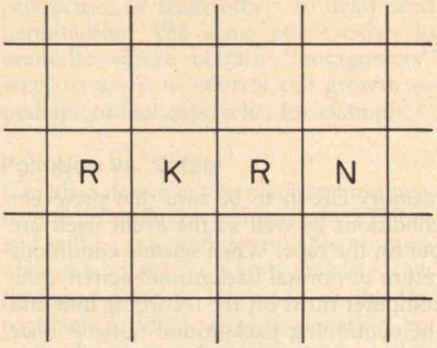
The other is from Woodrow Johnson: While it is acceptable to put a foot in fairyland to make rules as a condition for a problem, do the rules for scientific inquiry allow one to extrapolate particulars from what may be a general truth? The answer says that each family has *an average* of one daughter. Thinking in general terms of statistics, it might be true. Getting into the nitty-gritty of specifics, it is a common occurence that some marriages are sterile and others produce only daughters — two subgroups with eternal life! The answer also seems to assume that the male-female ratio is naturally one to

Number of families	25		50		25	
	Boys	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*
P distribution of offspring	40	60	50	50	60	40
Number of offspring	25	38.5	50	50	25	16.7
Overall ratio			100	104.2		

one. In the real world, at least, a predictable feature of large human populations is that for every 41 births, the odd spare is a male. To solve the problem, it seems one should recognize two populations, the Mortals and the Immortals. The Immortals are members of an even numbered set, since people enter by pairs when they marry and leave by pairs when their sons are born. Therefore, the male-female ratio is one to one for the Immortal population. For the Mortal set the male-female ratio would no doubt begin at 21:20 but would soon be different, with the Immortals sending extra daughters, begat from their Sisyphean labor in trying to get a son. With an ample supply of mates for the spare males, a population increase in both sets would seem initially imminent. Over a vast expanse of time, would all males become Immortal from gradually marrying sterile and daughter-only mates? Would the adult Mortal population become an endless line of nubile maidens, wandering toward the lunch counter to commit suicide? One feels that the above is a likely outcome if the rules are followed as given.

Proposers' Solutions to Speed Problems

SD 1



SD 2 Counterclockwise, as viewed from above.

Allan J. Gottlieb, who is Coordinator of Computer Activities and Assistant Professor of Mathematics at York College of the City University of New York, studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973). Send problems, solutions, and comments to him at York College, 150-14 Jamaica Avenue, Jamaica, N.Y., 11451.

An Institute Informant

The Editors' digest of recent and current concerns at the Massachusetts Institute of Technology

Research Briefs

Climbing Pains?

Chondromalacia of the kneecap? You probably are a victim without knowing it (most Americans are), but don't rush to the nearest doctor.

Chondromalacia is a form of damage to knee-joint cartilage caused by excessive pressure on a small region of the kneecap when the knee is bent at 50° to 60°, as in climbing stairs. It is at once the same and different from osteo-arthritis, a progressive disease of joints which is painful and even disabling. Robert M. Rose, Professor of Materials Science and Engineering, has demonstrated that osteo-arthritis results from damage to bone under joint cartilage: the bone is designed to absorb sudden shocks to the joint, but in arthritis the bone loses this ability and cartilage is painfully damaged. Chondromalacia is different, even beneficent: these repeated shocks cause the bone to become less rigid and so better protect cartilage. Why?

Professor Rose is bringing what he calls a "biomechanical" point of view to this question, exploring the interrelations of bone and cartilage under differing conditions. He hopes the result will be better therapy and perhaps even prevention of osteo-arthritis.

Earthquakes on the Sea Floor

A new underwater seismometer with a memory has been successfully tested in the Indian Ocean, and widespread use promises to add new details to our knowledge of continental movements, says Sean C. Solomon, Assistant Professor of Geophysics. The MITOBS — M.I.T. Ocean Bottom Seismometer — sinks to the ocean floor when launched and after a pre-set time interval returns to the surface for recovery. Meanwhile, MITOBS has selected and recorded — at least a month of data — all significant seismic events detected at its ocean-bottom site.

Everything the seismometer detects goes into a short-time memory circuit before being discarded. When MITOBS detects a seismological event, a computer turns on a recorder and goes back into the memory circuit to be sure that pre-event conditions as well as the event itself are put on the tape. When seismic conditions return to normal background activity, the computer turns off the recording unit and the continuing background noise is once again stored briefly before being discarded. Because it thus screens its own output, MITOBS can operate for up to a month, far longer than most ocean-bottom seismometers now in use.

Fast Program for a Machine Tool

A new system of interactive graphics is so simple to use that a machinist with no knowledge of computers can program a numerically-controlled machine tool after only a few hours of practice; a computer substitutes for the computer expertise which is otherwise required.

It works this way: the machinist sits in front of a display of his workpiece, tool, and hardware on a cathode-ray (television) tube. He uses hand cranks to guide the image of the tool through the movements necessary to make the part; the computer automatically writes a program by which it will move the tools themselves over the workpiece in precisely the same way.

The system, developed as part of a Ph.D. thesis by David C. Gossard in the Department of Mechanical Engineering, is called analogic part programming.

Superconducting Generator

The five to ten megawatts of electric power it will produce will flow into the Cambridge Electric Light Co.'s lines — a modest byproduct of a $4.6 million project for construction of a pilot-model superconducting generator. The superconducting feature — minimal electrical resistance exists in superconducting materials at very low temperatures — will permit high-voltage operation and higher efficiency, and the machine to be built at M.I.T. will have a number of "far-fetched" features to improve both efficiency and reliability. The job will be done by E.R.D.A. in the Electric Power Systems Engineering Laboratory under the direction of Gerald L. Wilson, Philip Sporn Professor of Energy Processing.

International Environmentalism

If a hypothetical global monitoring system detects a dangerous environmental threat, what then? What are the chances of taking international action in time to make any difference? And how in general can nations solve environmental problems that cross national boundaries?

Such questions — the political, social, and economic implications of global environmental monitoring — are now "a permanent aspect of international affairs," says Professor Eugene B. Skolnikoff, Director of the Center for International Studies, and they are the subject of a new program under the direction of George W. Rathjens, Professor of Policital Science.

Digital Signal Processing

Digital signal processing — a significant tool for workers in fields as diverse as biochemical engineering, radar, acoustics, speech communication, nuclear science, and image processing — is now the topic of a 21-tape self-study course now available in color videotapes from the M.I.T. Center for Advanced Engineering Studies.

The lecturer is Alan V. Oppenheim, Cecil H. Green Professor of Electrical Engineering. Purchase price for the 21-tape set is $6,180; the set is also available for rental ($646 for 105 days), and individual tapes may be bought or rented.

How Oil Slips Out of a Slick

Managing oil spills depends on understanding the "exact nature of the unstable boundary between oil and water," says Jerome H. Milgram, Associate Professor of Naval Architecture. For example, what causes bubbles of oil to separate themselves from a contained oil slick, flowing under the containment?

Such understanding is the goal of a new precision flume in the Parsons Laboratory for Water Resouces; it's part of a long-range program to determine "the most effective methods and equipment for cleaning up oil spills on the high seas," says Professor Milgram.

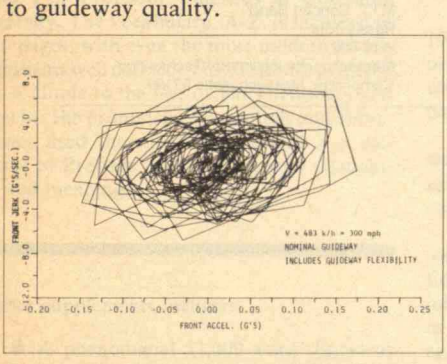
Down to the Sea With $1.88 Million

New technologies for use at sea, new methods of harvesting living and mineral marine resources, and promotion of proper coastal development are the three principal focuses of M.I.T.'s Sea Grant Program, for which some $1.88 million will be available in 1976-77. Of this, $1.1 million is M.I.T.'s share of funds from N.O.A.A.'s Office of Sea Grant.

High-Speed Guideway Construction

Computer programs to simulate the performance of proposed high-speed ground transportation systems by J. Karl Hedrick, Associate Professor of Mechanical Engineering at M.I.T., may help resolve potential conflicts between vehicle designers and guideway contractors.

Vehicle designers prefer what Professor Hedrick calls "an overdesigned, overtoleranced guideway" so that their vehicles will surely meet ride quality specifications. But the result can be guideway requirements "so stringent that guideway contractors are unable to accurately estimate their costs." Professor Hedrick's work, reported during the winter to the annual meeting of the American Society of Mechanical Engineers, provides a general method for modeling the ride characteristics of a vehicle design and relating those to guideway quality.



Computer-simulated movements of a point just above the front suspension of a high-speed (300-m.p.h.) vehicle on a guideway. The accelerations shown (vertical) are the results, for a particular vehicle, of irregularities in the guideway surface, guideway elasticity between piers, and vehicle suspension characteristics. The range of horizontal accelerations is between −0.15 and +0.15 G's.

Controlling Cell Growth

Cytokinins are plant hormones that promote growth, retard aging, and help to control cell differentiation and the ripening of fruit. Now Sidney M. Hecht, Associate Professor of Chemistry, has discovered how to make cytokinin "antagonists" which serve to retard growth. There is a family of such compounds, some "antagonists" working to retard the production of fruit, others to delay seed germination. The same effect exists in animals, where certain "antagonists" seem to work to control cell growth — perhaps of leukemic cells, for example.

Pollution vs. Safety

Can aircraft engines be made to meet new federal air pollution standards by 1979 — and still be safe and dependable on takeoff and landing? No simple problem, says Professor John B. Heywood of the Department of Mechanical Engineering, because the same factors that cause pollutants also ensure steady, reliable combustion in jet engines.

Part of the difficulty is that jet engines produce different pollutants under different conditions — carbon monoxide and hydrocarbons while idling, oxides of nitrogen while accelerating. A modification to control one pollutant under one condition has negative results on other pollutants, or perhaps on engine performance, under other conditions. A vexing problem, thinks Professor Heywood, and 1979 looks like a tight deadline.

The Boomtown Phenomenon

What happens to people who live in the Wyoming desert when a new strip mine is opened there?

The answer is that they are suddenly unwilling pioneers in a modern boomtown, confronted with disorderly growth, high costs, inefficient land use, and private and public irresponsibility. Lawrence E. Susskind, Associate Professor of Urban Studies and Planning, has been asked by the National Governors Conference to look for ways to minimize the ill effects of the "boomtown phenomenon." There will be handbooks for citizens of "threatened" towns and for companies entering new areas, case studies of citizen and state actions, and a motion picture to help towns alert their residents to dangers and solutions.

New England's Possible Futures

Are the "doomsters" right about the declining future of the New England economy — high energy costs, high transportation costs, high costs of government?

For an answer, turn to the Joint Center for Urban Studies of M.I.T. and Harvard a year from now. Under a $150,000 grant from the Economic Development Administration, the Center is at work on a one-year study of the New England economy, including especially the impact of federal and industrial capital spending programs.

This press can squeeze a minute mineral sample to 300,000 atmospheres of pressure; its "jaws" are two diamonds each smaller than the head of a pin. Designed and built by Chien-Min Sung, its purpose is to study the transition of olivine into spinel — a phenomenon thought to be associated with earthquakes which occur at great depths in the earth.

Pressing Olivine Into Spinel

A tiny press built in the Department of Earth and Planetary Sciences can apply pressures of up to 300,000 atmospheres to mineral samples. That's enough to change the mineral olivine into the mineral spinel, which is the point of the device built by Professor Roger G. Burns and Chien-Min Sung, a graduate student. The olivine-spinel transition is thought to figure in deep earthquakes which occur 400 to 600 kilometers beneath the surface of the earth. At this depth terrestrial materials should be soft and pliable; the speculation is that olivine — a greenish mineral which makes up some 60 per cent of the earth's mantle — in a subsiding continental plate may suddenly turn into spinel; and if that transition occurs fast enough, it may be a source of deep earthquakes.

Why Innovation Succeeds — or Fails

"The Management of Innovation" will be the topic for at least four members of the M.I.T. faculty and a number of guests in an all-day seminar in New York on December 9, arranged and sponsored by the M.I.T. Alumni Center of New York.

The emphasis will be on concrete examples to demonstrate how and why technological innovations are succeeding or failing, as the case may be.

Registration will be $65, including luncheon. For further information and reservations, write or call the Center at 50 East 41st Street, New York, N.Y., 10017, (212) 532-8181.

How to Escape the Energy Cloud

Carroll L. Wilson, who is now Mitsui Professor in Problems of Contemporary Technology at M.I.T., was the first General Manager of the U.S. Atomic Energy Commission, established after World War II to develop peacetime uses of nuclear energy — among them nuclear power.

But now, he says, it's time to turn away from such high-technology energy-creating systems. At Energia '76, an international conference on energy economy organized by Norwegian industry and government leaders in Oslo this spring, Professor Wilson urged that mankind "liberate itself from the mental fixation that high per-capita energy consumption is indispensable to a high quality of life."

He proposed the experiment of "applying modern technology to the goal of maximum comfort and convenience with minimum energy consumption"; the result, he thinks, will be less reliance on "large centralized concentrations of machinery and the accompanying bureaucracies." (*See page 24 this issue.*)

Despite their rich endowment of both fossil and hydroelectric resources, it seems to be a lesson the Norwegians have already learned, said Professor Wilson. Energy consumption in Norway is 4.3 kilowatts per person per year; per capita annual G.N.P. is $3,730. This compares with U.S. energy consumption of 10.9 kilowatts with G.N.P. of only $5,590. Sweden, with G.N.P. similar to that of the U.S., uses only half as much energy, said Professor Wilson.

Such variations in energy use suggest to him that "important savings potentials" are waiting to be discovered. That is one reason for his leadership of an M.I.T.-based Workshop on Alternative Energy Strategies, a private, international study of world energy alternatives to the year 2000. W.A.E.S., he said, is about to publish an analysis of comparative energy use by various countries, and he thinks it will be an important tool in planning future world energy strategies. — *J.M.*

Performance of Capital

When you invest capital in a U.S. food industry, what rate of return should you expect? In a U.S. machine tool business? In a French high-technology industry?

The answers are elusive, and now they will be the subject of a major study by the M.I.T. Project on International Business, co-sponsored by the Center for International Studies and the Sloan School of Management. The goals: "to analyze the trend during the past 15 to 20 years in the rate of return to capital in major industrial sectors in all major industrial countries (with and without exclusion of 'illusory' profits due to inflation) . . . to compare the rates of return among countries, (and to) compare trends in the rate of return to capital with those in the cost of capital." The results will be "of major importance as a basis for both corporate and public policy," says Professor Everett E. Hagen, Chairman of the Project's Directing Committee.

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